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# VARIATIONS OF LISTERIA MONOCYTOGENES PRODUCED BY BETA PARTICLES FROM RADIOPHOSPHORUS

MATTHEW C. HUNTER,[1] GRANT L. STAHLY AND WM. G. MYERS[2]

Departments of Bacteriology and Medicine, Ohio State University
Columbus, Ohio

One of the most widely used methods to induce variations in micro-organisms is the application of various types of radiation. Ultraviolet light and X-rays have been used most frequently for this purpose. While beta particles have previously been used to irradiate bacteria, they have usually been employed to determine the lethal effects. Beta radiations were obtained from cathode ray tubes or from some naturally radioactive substance which also emitted alpha particles or gamma rays. Recently the radioactive isotope of phosphorus, commonly referred to as $P^{32}$, which emits only beta particles has been made available. One of the advantages of using this source of beta particles is that the radiophosphorus, in the form of a phosphate, can be dissolved and distributed uniformly throughout the medium. This minimizes the absorption of the beta particles by materials other than the bacterial cell substance and the medium, thus making possible the more accurate estimate of the amount of radiation and the number of cells which are affected by it.

Although von Schroetter (1927) observed some interesting morphological changes while studying the action of radium on microorganisms over twenty years ago, the use of ionizing radiations, other than X-rays, to induce variations in microorganisms has largely been limited to the past ten years. Whelden (1940) demonstrated variant production in bacteria by low voltage cathode rays. Neutrons were shown to induce variation in *Penicillium notatum* (Myers and Hanson, 1945: Hanson, Myers, Stahly and Birkeland, 1946) and beta radiations from radiophosphorus were shown to produce variations in *Neurospora crassa* (Giles and Lederberg, 1948). Morphological and physiological variations of *Bacillus globigii* induced by beta particle irradiation were reported previously (Hunter, Stahly and Myers, 1948). In the present study, the effects of ionizing radiations on the morphologic, biochemical, immunogenic, and pathogenic characteristics of *Listeria monocytogenes* were investigated.

## MATERIALS AND METHODS

The Ohio State University stock strain 144 of *Listeria monocytogenes* was selected as the test organism. This strain formed small, convex, grayish-white colonies with a regular periphery and produced a small zone of beta hemolysis on horse blood agar. Less than 1 per cent of the colonies appeared slightly larger and rougher than the rest. A smooth colony was picked and restreaked; no more rough colonies appeared during serial transfer on five plates. A colony, picked from the fifth plate, was inoculated upon a blood agar slant and was kept as the stock culture.

[1]Present address: Smith, Kline and French Laboratories, Philadelphia, Pa.

[2]Julius F. Stone Fellow in Bio-Physical Research.

The radiophosphorus used in these experiments was obtained from the Atomic Energy Commission at Oak Ridge, Tennessee, in the form of potassium dihydrogen phosphate with a specific activity of approximately two $P^{32}$ atoms per ten million phosphorus atoms. A 2 per cent solution of the phosphate was prepared at the Ohio State University Medical Center. A control solution which contained the same concentration of non-radioactive potassium dihydrogen phosphate was prepared also. The amount of standard sodium hydroxide required to adjust the pH of the control solution to 7.0 was determined; this amount of the same base was also added to the radioactive solution to adjust it to the same pH. Both of these solutions were sterilized by autoclaving for 20 minutes at 15 pounds pressure.

The organism was grown on a blood agar slope for 24 hours and then the cells were suspended in 5 ml. of doubly distilled water. Both the exposure tube and the control tube were prepared by transferring 1 ml. of the bacterial suspension, by means of an automatic pipette, into 10 ml. of each of the phosphate solutions. At the time of inoculation the radiophosphate solution had an activity of 120 microcuries per ml. Application of the formula of Marinelli et al (1948) modified by an estimate of the amount of beta ray absorption by the test tube, resulted in a calculated value of approximately 45,000 equivalent roentgen units to which the culture was exposed during 11 days.

At 24-hour intervals samples were withdrawn from both the exposure tube and the control tube and streaked over a series of beef-infusion horse-blood agar plates. These plates were examined after 48 hours of incubation at 37 C. and any colony which appeared different from the stock colonies was picked and streaked upon a medium of the same composition. On the plates streaked from the control tube no colonies were detected which differed from the normal colonies of the parent strain. From the exposure tube twenty-one colonies were selected which differed from the parent strain in some morphological characteristic discernible under the stereoscopic microscope. One of these strains (number 4) was lost during subculture procedures. The other twenty strains were examined with respect to their morphologic, antigenic, physiologic and pathogenic characteristics.

## EXPERIMENTAL RESULTS

### *Morphological Characteristics*

The twenty strains which were isolated differed from the parent strain and generally from each other in one or more of the following characteristics: size, opacity, elevation, color, texture, roughness, and degree of hemolysis on blood agar of the colonies and the size, shape and staining reactions of the cells.

### *Agglutination and precipitation reactions*

An antiserum was prepared against the unirradiated parent strain by the procedures recommended by Paterson (1940) for the demonstration of a somatic antigen common to all types of *Listeria monocytogenes*. Cell suspensions of each of the twenty isolated strains were prepared in the same manner as the immunizing antigen was prepared. The original immunizing antigen was used for the parent strain in the agglutination tests.

In Table I the titers of the parent strain antiserum for each cell suspension are recorded. The tests were set up in geometric series starting at a dilution of 1 : 20. Readings were made after incubation for 12 hours at 37 C. and again after storage overnight at 4 C. No differences were observed in the two readings.

The results of these agglutination reactions indicate that strains 3 and 10 either were variants of *L. monocytogenes* which had been altered sufficiently to result in a change in the surface antigens or were grampositive, non-sporeforming, motile contaminants. Strains 19 and 21 agglutinated spontaneously in saline when agglutination reactions were attempted. Since physiological reactions did not characterize these strains as *L. monocytogenes*, each of them was tested by the precipitin reaction. Although strains 9 and 16 were agglutinated typically by

antiserum prepared against the parent strain, they were so different from the parent culture physiologically, that they were included in the precipitin reactions which were run subsequently.

For the precipitin reactions the same antiserum was used as had been used for the agglutination tests. The antigens were prepared by growing each strain in 1 per cent glucose yeast extract broth for 24 hours, after which the cells were washed twice in distilled water and suspended in physiological saline. A count was made on each suspension by the serial dilution method of McCrady (1918) and the most probable numbers were determined by consulting the tables of Hoskins (1934). Each suspension was adjusted to approximately 50 million viable cells per ml. by the addition of normal saline. These suspensions were frozen and thawed three times by placing them in the deep freeze unit overnight and allowing them to thaw out the following day. The antigens were then clarified by filtration through Seitz disks. Precipitation tests were set up by placing 0.1 ml. of the antiserum in a series of precipitin tubes and overlaying the antiserum with 0.1 ml. of various dilutions of each antigen. The controls used were: antiserum plus saline, antiserum plus 1 : 10 yeast extract broth, antiserum plus 1 : 10

TABLE I

AGGLUTINATION TITERS OF THE ANTISERUM OF THE PARENT STRAIN FOR VARIANTS OF *Listeria monocytogenes*

| STRAINS | DILUTION OF ANTISERUM OF PARENT STRAIN | | | | | | | | SALINE CONTROL |
|---|---|---|---|---|---|---|---|---|---|
| | 1/20 | 1/40 | 1/80 | 1/160 | 1/320 | 1/640 | 1/1280 | 1/2560 | |
| Parent, 1, 2, 5–8, 11–18, 20.... | + | + | + | + | + | + | — | — | — |
| 9..... | + | + | + | + | + | + | + | ..... | ..... |
| 19, 21..... | + | + | + | + | + | + | + | + | + |
| 3, 10..... | — | — | — | — | — | — | — | — | — |

nutrient broth, and normal serum from an uninoculated rabbit plus varying dilutions of the antigen of the parent culture. Reactions were read after 3 hours at 37 C. and again after 24 hours at 7 C.

All of the controls were negative. Strains 3, 9, 16, 19 and 21 showed precipitin reactions similar to those of the parent strain. Strain 10 showed no reaction when combined in any concentration with the antiserum prepared against the parent strain. This strain could have resulted from a mutation which inhibited the production of some constituent which was an essential part of each antigenic component of the cell. But, since it could not be established that this strain was a progeny of the parent strain through antigenic or physiologic characteristics, it was not included in the subsequent studies.

*Physiological reactions*

Abilities to ferment carbon compounds and litmus milk, to reduce nitrate, to produce acetylmethylcarbinol and indol, and to give a positive methyl red reaction were tested with each strain in order to determine variations in physiological characteristics.

Each strain was inoculated into media containing 1 per cent of the compounds listed in Table II. These media were prepared by adding solutions of the carbon sources, which had been filtered through Seitz disks, to a 1 per cent tryptone broth adjusted to pH 7.0 and to which had been added brom cresol purple indicator. While the majority of the strains fermented the same carbohydrates, numbers 3, 8, 9, 16, 19 and 21 differed widely. Number 3 fermented mannitol and numbers

3 and 16 fermented galactose both of which the parent strain was unable to utilize. They, as well as strains 8, 9, 19 and 21, lost the ability to ferment one or more of the carbohydrates which the parent strain fermented.

Duplicate tubes of litmus milk were inoculated with each strain, incubated at 37 C, and observed at two-hour intervals for 14 hours and again after 24, 48 and 72 hours. Tubes which showed no reaction after 72 hours were observed for an additional six days but no further change was evident. The unirradiated parent strain reduced the indicator in 8 hours and produced acid in 72 hours. The two most striking variations evidenced in litmus milk were the failure to produce any observable reaction (strains 9, 16, 19 and 21) and the failure to reduce the indicator before producing acid (strains 3, 13, 15, 17 and 18).

Each strain was tested for its ability to reduce nitrates, to produce acetylmethylcarbinol and indol, and the ability to lower pH sufficiently to give a positive

TABLE II

FERMENTATION REACTIONS OF IRRADIATED STRAINS OF *Listeria monocytogenes*

| Carbon Compound | Strain | | | | | | |
|---|---|---|---|---|---|---|---|
| | Parent, 1, 2, 5, 6, 7, 11, 12, 13, 14, 15, 17, 18 20 | 3 | 8 | 9 | 16 | 19 | 21 |
| Arabinose | + | + | + | + | + | + | — |
| Dextrin | + | — | + | + | + | + | — |
| Dulcitol | — | — | — | — | — | — | — |
| Galactose | — | + | — | — | + | — | — |
| Glucose | + | + | + | + | + | + | — |
| Inositol | — | — | — | — | — | — | — |
| Inulin | — | — | — | — | — | — | — |
| Lactose | + | — | — | — | — | — | — |
| Mannitol | — | + | — | — | — | — | — |
| Melezitose | + | — | + | — | — | — | — |
| Raffinose | + | + | + | + | — | + | — |
| Rhamnose | + | + | + | — | + | — | — |
| Salacin | + | + | + | — | + | — | — |
| Sucrose | + | — | + | + | — | + | — |
| Xylose | + | — | + | — | — | + | — |

+ Production of acid; —, growth but no acid production.

methyl red test. Equally turbid suspensions of each strain were prepared for the inocula and the tests were carried out as prescribed in Manual of Methods for Pure Culture Study of Bacteria. All strains failed to produce indol. Ten strains produced reactions identical with those of the parent strain. Results are listed in Table III. Those strains which differed from the parent only in the production of weak Voges-Proskauer reactions all produced acid in litmus milk without preliminary reduction of indicator. Strain number 3 behaved differently from the others by producing acid in litmus milk without preliminary reduction of indicator and by showing a negative Voges-Proskauer reaction. Strain number 16 differed by showing no reaction in litmus milk, by producing a faintly positive methyl red reaction and by reducing nitrates. The other strains which showed variation all gave negative reactions in litmus milk and in the four tests indicated in Table III.

*Pathogenesis*

In order to determine whether any variations had occurred in the pathogenicity of these strains, they were inoculated into embryonated chick eggs. Each strain

was grown for 48 hours on blood agar slopes which were then washed down with physiological saline. These saline suspensions were adjusted to equal turbidities and varying dilutions were inoculated on the chorio-allantois of 11-day old chick embryos. Immediately following inoculation, the most probable number of viable cells in each suspension was determined by the serial dilution method. Each of five embryonated eggs was inoculated with 0.5 ml. of each dilution of each suspension.

TABLE III

ADDITIONAL BIOCHEMICAL REACTIONS OF VARIANTS OF *Listeria monocytogenes*

| STRAIN | TEST | | | |
|---|---|---|---|---|
| | Nitrate | MR | VP | Indole |
| Parent, 1, 2, 5, 6, 7, 8, 11, 12, 14, 20 | — | ++++ | ++++ | — |
| 3, 9, 19, 21 | —* | —* | —* | —* |
| 13, 15, 17, 18 | — | ++++ | ++ | — |
| 16 | ++++ | + | — | — |

*=poor growth medium

TABLE IV

CHICK EMBRYOCIDAL ACTIVITY OF STRAINS OF *Listeria monocytogenes* IN TWO DAYS

| STRAIN | MORTALITY RESULTING FROM THE INOCULATION OF INCREASING NUMBERS OF CELLS | | | | | | |
|---|---|---|---|---|---|---|---|
| | $5 \times 10^2$ | $5 \times 10^3$ | $5 \times 10^4$ | $5 \times 10^5$ | $5 \times 10^6$ | $5 \times 10^7$ | $5 \times 10^8$ |
| Parent | 0/10 | 0/10 | 6/10 | 10/10 | 10/10 | 10/10 | ... |
| 1 | 0/5 | 0/5 | 2/5 | 5/5 | 5/5 | ... | ... |
| 2 | 1/5 | 3/5 | 5/5 | 5/5 | 5/5 | ... | ... |
| 3 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | ... |
| 5 | 0/5 | 1/5 | 1/5 | 3/5 | 5/5 | ... | ... |
| 6 | 1/5 | 2/5 | 5/5 | 5/5 | ... | ... | ... |
| 7 | 2/5 | 3/5 | 5/5 | 5/5 | ... | ... | ... |
| 8 | 0/5 | 3/5 | 4/5 | 5/5 | ... | ... | ... |
| 9 | 0/5 | 0/5 | 0/5 | 0/5 | ... | ... | ... |
| 11 | 0/5 | 0/5 | 1/5 | 2/5 | 5/5 | ... | ... |
| 12 | 0/5 | 1/5 | 3/5 | 4/5 | 5/5 | ... | ... |
| 13 | 0/5 | 2/5 | 2/5 | 3/5 | 5/5 | ... | ... |
| 14 | 0/5 | 3/5 | 3/5 | 5/5 | 5/5 | ... | ... |
| 15 | 0/5 | 1/5 | 1/5 | 3/5 | 5/5 | ... | ... |
| 16 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 |
| 17 | 0/5 | 0/5 | 2/5 | 3/5 | 5/5 | ... | ... |
| 18 | 0/5 | 1/5 | 3/5 | 5/5 | 5/5 | ... | ... |
| 19 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | ... | ... |
| 20 | 1/5 | 4/5 | 5/5 | 5/5 | 5/5 | ... | ... |
| 21 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | 0/5 | ... |

All 19 of the possible variants showed some slight variation, but 5 strains showed a decrease in virulence which was beyond the range attributable to experimental error. These results are recorded in Table IV.

Fifty thousand viable cells of the parent strain killed three of the five embryos when first tested and two of the five when rechecked. Five hundred thousand

or more cells consistently produced 100 per cent mortality. Fifty million viable cells of strains 3, 9, 16, 19 and 21 failed to kill any embryos. Five hundred million viable cells of strain 16 produced no deaths in the chick embryos. Virulence tests of all five variants and the parent culture were repeated in embryonated eggs and the same results were observed.

Each strain which showed significant variation in virulence for the chick embryo was further tested for pathogenicity in mice. Young female white mice were injected intraperitoneally with suspensions of the variants which had been standardized previously. In some preliminary tests, the injection of thirty-nine million viable cells of the parent strain killed all of the mice within two days. To assure that the inocula contained the same or larger numbers of variant cells than were present in a lethal dose of the parent strain, a dosage of fifty million viable cells was selected as the standard inoculum.

Twenty mice were used for each strain and the results are recorded in Table V. Whereas fifty million cells of the parent strain killed all of the mice before the fifth day a similar inoculum of each of the other strains resulted in only 5–10 per cent of deaths.

TABLE V

MORTALITY IN 20 MICE INJECTED INTRAPERITONEALLY WITH 5 x $10^7$ CELLS OF VARIANTS OF *Listeria monocytogenes* INDUCED WITH RADIOPHOSPHORUS

| STRAIN | DEATHS ON DAY | | | | | | | | PERCENT MORTALITY |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
| Parent | 4 | 9 | 6 | 1 | 0 | 0 | 0 | 0 | 100 |
| 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 9 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 5 |
| 16 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 19 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 |
| 21 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 |

Those mice which were inoculated with variant strains, and which survived, were reinoculated six weeks later with a lethal dose of the parent strain to determine whether they were immune. Each mouse was injected intraperitoneally with approximately 50 million viable cells. Twenty mice which had not previously been inoculated were treated similarly and they served as the controls. All of the mice died by the seventh day. This indicates that any immunity against the parent strain, which may have been conferred by the variant strains in the manner in which they were used, was of such an insignificant or transient nature as to be of little or no value for protection.

## DISCUSSION

Nineteen different strains were isolated from a suspension of *Listeria monocytogenes* after exposure to beta radiation. Although these strains differed from the unirradiated parent strain in colony characteristics, all were similar in general cell morphology, in motility, and in the possession of some common antigen.

Most of the changes noted in this investigation, as in the case with most studies of induced mutations in bacteria, were changes involving loss of metabolic abilities and/or pathogenicity. In two instances, however, enzymatic activities which were either absent or completely suppressed in the parent strain were observed in the mutants; strain number 3 produced acid from mannitol and galactose and

strain number 16 fermented galactose and reduced nitrates to nitrites. It is conceivable that the apparent gain of enzymes as required by these reactions might be due to the loss of enzyme inhibitors. No information to support or refute this hypothesis was obtained in the present investigation.

The five strains of *L. monocytogenes* which showed alteration in pathogenicity also failed to hemolyze horse blood, to ferment lactose and melezitose, and to produce strongly positive reactions in the methyl red and Voges-Proskauer tests. In addition to the changes which were common to the five strains, each of these strains varied in some manner which was not common to the others or the parent. It seems improbable that each physiologic alteration observed in this investigation was the result of a "hit" by a beta particle of a different sensitive region. A more probable mechanism might be that in several instances either a single beta particle struck a center of genetic determinants which resulted in the simultaneous alteration of several physiologic characteristics or that a single determinant was altered which alone influenced several enzyme systems.

Although administration of large inocula of the five non-virulent living cultures did not protect mice challenged six weeks later with the virulent parent culture, one should not conclude that no protection can be afforded by this means. A more detailed study with modified procedures should be made.

## SUMMARY

Cells of *Listeria monocytogenes* were suspended in a medium containing radioactive phosphorus at a total radiation level of approximately 45,000 equivalent roentgens over an eleven-day period. At 24-hour intervals samples were removed and streaked on suitable media. Nineteen strains were isolated which showed variations from the parent in their colonial characteristics. Some of these also showed variations in physiological characteristics, in their antigenicity, and in their capacity to produce disease.

Most of the physiological changes which were detected were indicated by the inability of the variant to produce metabolic reactions which the parent strain was capable of producing. Two strains differed, however, in being able to produce biochemical reactions which the parent was unable to do. Five strains exhibited a greatly decreased virulence for the chick embryo and the white mouse. Heavy inocula of living cells of these strains, however, failed to protect mice when challenged with the parent strain six weeks later.

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# A COMPARISON OF STATURE, WEIGHT, AND HEAD MEASUREMENTS AMONG CATHOLIC, PROTESTANT, AND JEWISH STUDENTS[1]

DAVID C. RIFE[2]
The Institute of Genetics
Ohio State University, Columbus, Ohio

Over a period of six years records have been made of several genetic and anthropometric traits as they occur among students taking an introductory course in human heredity at Ohio State University. The traits include blood groups, M and N blood types, taste reaction to phenyl-thio-carbamide, handedness, hair color, dermatoglyphics, pain threshold, stature, weight, head length and breadth. National origin and religion have also been recorded. The objectives of this project are to determine how effective cultural differences, such as nationality, geographic region, and religion have been in preventing random mating, and to what extent biological variations may be associated with cultural differences.

TABLE I

| Group | No. Ind. | O | A | B | AB | % Fingers with Whorls | % Left-Handedness |
|---|---|---|---|---|---|---|---|
| Jewish Students... | 330 | 35.45 | 40.30 | 15.17 | 8.48 | 38.32 | 15.84 |
| Protestant Students..... | 1,060 | 45.28 | 40.47 | 11.12 | 3.11 | 28.27 | 10.51 |
| Jews, New Orleans | ..... | ..... | ..... | ..... | ..... | 42.7 | |
| Jews, Odessa..... | 1,475 | 36.6 | 41.7 | 15.6 | 6.1 | | |
| Unselected Whites, U.S.A.. | 20,000 | 45.0 | 41.0 | 10.0 | 4.0 | | |
| Unselected Whites, U.S.A.. | 300 | ..... | ..... | ..... | ..... | 25.7 | |

No selection has been made in obtaining these data, all students registered in the course being required to give them. Protestants comprise by far the largest proportion of the group, almost all of them being of British or Northwestern European origin. Jews rank second in number, the great majority of them being of Russian and Central European origin. Catholics of British and Northwestern European origin comprise the third group in order of size. Several other groups, including Negroes, Italians, Greeks, and other small ones, are as yet of insufficient size to warrant valid comparisons.

Comparisons of Protestants and Jews in respect to the frequencies of the blood groups, dermatoglyphics, handedness, and other traits have been reported in detail elsewhere (Rife, 1948) and reveal certain differences of significance (Table I). Jews are characterized by a higher frequency of blood group antigen B than are the Protestants, but there is no difference in respect to the incidence of antigen A. There are also significant differences in respect to the occurrence of whorls on finger-tips, and of left-handedness in the two populations. Note the close correspondence between the blood group distributions of Jewish students and of Jews in

[1]This paper was presented at the meeting of the American Society of Human Genetics in New York, December, 1949.

[2]Department of Zoology and Entomology.

Odessa. Also note that the Jews in New Orleans differ from the unselected population in regard to whorls on finger-tips in much the same way as do Jewish students from Protestant students.

Let us now consider comparisons of stature, weight, head length, and head width among Russian and Central European Jews, British Protestants, Unclassified Protestants, and Catholics of British and Northwestern European descent. Table II shows comparisons of stature and weight among females. Differences are obvious, Jewish girls being the shortest, Catholics the tallest. The difference between British Protestants and Unclassified Protestants is insignificant. All of the other differences in stature are quite significant. All four groups are quite similar in weight.

Table III shows comparisons of stature and weight among males. Here again we find obvious differences, Jews being the shortest and Catholics the tallest. The differences between both classes of Protestants and Jews are highly significant. Although Catholics are the tallest, the differences between them and the

TABLE II

FEMALES

| Group | Number | Stature | Number | Weight |
|---|---|---|---|---|
| Russian and Central European Jews. | 188 | 64.00 ± 0.16 | 186 | 125.84 ± 1.19 |
| British Protestants | 178 | 64.82 ± 0.17 | 175 | 122.56 ± 1.42 |
| Unclassified Protestants | 338 | 64.54 ± 0.13 | 316 | 123.26 ± 0.92 |
| Unclassified Catholics | 34 | 65.21 ± 0.42 | 35 | 123.85 ± 2.00 |

TABLE III

MALES

| Group | Number | Stature* | Number | Weight* |
|---|---|---|---|---|
| Russian and Central European Jews. | 83 | 67.71 ± 0.30 | 83 | 149.96 ± 2.15 |
| British Protestants | 153 | 69.00 ± 0.22 | 153 | 151.24 ± 1.23 |
| Unclassified Protestants | 178 | 69.31 ± 0.17 | 177 | 151.16 ± 1.86 |
| Unclassified Catholics | 51 | 70.19 ± 0.35 | 51 | 159.50 ± 3.21 |

*Stature is recorded in inches, weight in pounds.

Protestants are not statistically significant. The two types of Protestants are quite similar. The trends among the males in stature are the same as those among the females. Protestant and Jewish men show no real differences in weight, but Catholic men are significantly heavier than the other groups.

We shall now consider head measurements (Table IV). Note that the trends in head length correspond with the trends we found in stature. Jews have the shortest, Catholics the longest heads. This is what one might predict, as stature and head length usually exhibit a positive correlation. No differences are indicated between British and Unclassified Protestants. All of the other differences in head length are statistically significant.

In respect to head breadth, the greatest difference occurs between the two Protestant groups, the Unclassified Protestants having significantly broader heads. None of the differences between Catholics, Protestants, and Jews are of statistical significance.

Among males, we also find Jews have significantly shorter heads than do Protestants and Catholics (Table V). No significant differences are found between the two classes of Protestants, or between Protestants and Catholics.

Head breadth corresponds closely to what was observed among females, the greatest difference being between the two classes of Protestants, the Unclassified Protestants having the broader heads. No differences of significance are present between Jews, Protestants, and Catholics.

To recapitulate, Jewish students are shorter in stature and head length than are Protestant and Catholic students, whereas Catholic students are taller and have greater head length than do the other groups. No consistent differences in weight are apparent. Unclassified European Protestants have broader heads than do British Protestants.

TABLE IV**

FEMALES

| Group | Number | Head Length | Number | Head Breadth |
|---|---|---|---|---|
| Russian and Central European Jews. | 74 | 178.79 ± 0.79 | 74 | 144.05 ± 0.57 |
| British Protestants | 62 | 181.30 ± 0.95 | 62 | 142.58 ± 0.76 |
| Unclassified Protestants | 109 | 181.56 ± 0.54 | 109 | 144.47 ± 0.54 |
| Unclassified Catholics | 27 | 187.00 ± 2.06 | 27 | 143.30 ± 1.36 |

**Head measurements were not taken during the first years of the project, thus the numbers of individuals in Tables IV and V are considerably smaller than those shown in Tables I, II, and III. Measurements are in millimeters.

TABLE V

MALES

| Group | Number | Head Length | Number | Head Breadth |
|---|---|---|---|---|
| Russian and Central European Jews. | 28 | 187.80 ± 1.06 | 28 | 149.25 ± 1.51 |
| British Protestants | 60 | 193.30 ± 0.88 | 59 | 149.50 ± 0.67 |
| Unclassified Protestants | 73 | 192.27 ± 0.73 | 73 | 152.00 ± 0.66 |
| Unclassified Catholics | 38 | 192.87 ± 1.36 | 38 | 151.34 ± 1.25 |

These findings parallel those made earlier in respect to the blood groups, handedness, dermatoglyphics, and other traits. Cultural differences are accompanied by biological differences, presumably as the result of random drift in gene frequencies within each of the populations.

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**Animal Parasitology**

This manuel, with emphasis on the animal parasites of man, is designed for the introductory course in general parasitology. There are sections on the Platyhelminthes, Acanthocephala, Nemathelminthes, Annelida, Protozoa, and Arthropoda arranged in the order listed. Miscellaneous information in various places includes a list of reference books, bibliographic aids, zoological nomenclature, calibration of the microscope, construction and use of zoological keys, and parasitological techniques. There are numerous illustrations, tables of data, and an index.

The variety and amount of material in this guide and its arrangement allow the instructor much choice of what to cover in the classroom. The author, unlike so many authors of manuals, must believe in learning and discovering by drawing because he frequently recommends that drawings be made and he has not included sketches for the student to label. Unfortunately, I do not have a first edition with which to compare this revision.—*Carl Venard.*

**A Laboratory Manuel in Animal Parasitology,** by H. W. Manter. ix+121 pages. Lithioprinted. Spiral binding. Burgess Publishing Company, Minneapolis 15. Revised edition 1950. Price $2.25.

# SOME PARASITES OF THE PRAIRIE MOLE, SCALOPUS AQUATICUS MACHRINUS (RAFINESQUE)[1]

JOHN R. OLIVE
Department of Zoology, Colorado A & M College,
Fort Collins, Colorado

A parasitological examination of 42 specimens of prairie moles, *Scalopus aquaticus machrinus* (Rafinesque), taken in Perry, Champaign, and Franklin Counties, (Ohio) was undertaken to determine: (1) the species of parasites of the host, (2) the percentage of infection of moles with each species of parasite, and (3) the mean incidence of infection of the host.

The moles were obtained by trapping with the harpoon type of mole trap (Olive, 1946), and all but one of the animals were dead when recovered from the trap. Parasites were removed from the moles as soon as possible after trapping and were preserved in alcohol.

## ECTOPARASITES

### *Atricholelaps glasgowi*

The mite, *Atricholelaps glasgowi* (Ewing), was recovered from 37 moles of both sexes, which represented an infection of 90.4%. The number of mites per host varied from 1–120 with a mean incidence of 11.4.

The most heavily infected mole was an immature male from which 120 mites were recovered. The mites had caused a dermatitis on the sides and back of this animal, and apparently had loosened the fur in the head and neck region. Much of the fur was matted with excreta of the mites. The general condition and appearance of this mole showed evidence of malnutrition. It seemed that the constant irritation by the mites had affected the feeding of the mole, since, at the time of examination, the stomach contained only digestive juices while the small intestine contained parts of several June beetle larvae and grass roots.

None of the other mite-infected moles showed any evidence of being affected. It is conceivable, however, that mites may become a limiting factor in a mole population since Olson and Dahms (1946) found that *Liponyssus bacoti*, the tropical rat mite, produced a fatal anemia in laboratory animals that had become accidentally infected with the mite.

These authors attributed the deaths to anemia rather than toxic products produced by the mite, since the hosts "demonstrated a progressive blanching of the skin, which could be attributed to a loss of blood."

Two specimens of *A. glasgowi* were sent to Dr. E. W. Baker of the U. S. National Museum for confirmation of the identification.

### *Siphonaptera*

A single species of flea, *Ctenophthalmus pseudagyrtes* Baker, 1904, was recovered during this study.

This flea was found on 35 moles. This represented an infection of 83.3%. The number of fleas per host varied from 1–43 with a mean incidence of 7.

There was no evidence of any damage having been done to the host by this parasite.

### *Coleoptera*

The one species of beetle, *Leptimus testaceus* Mueller, 1817, recovered from 2 moles represented a percentage of infection of 4.7% with an incidence of 1.5.

[1]The investigation was conducted at the Ohio State University, Columbus, Ohio.

The first 3 specimens of this beetle were taken from a live mole. This is of particular interest since there is some controversy as to whether this beetle is a parasite. Comstock (1933) stated "Whether it (*L. testaceus*) is a parasite or merely a guest has not been definitely determined." Other entomologists suggested that the beetle might be feeding upon mites or dandruff scales found on the host. Morphologically it could well be a parasite. The dorso-ventral flattening and the presence of a tarsal claw are suggestive of a parasitic mode of life. It may be that the beetles left the moles very soon after death, not remaining nearly so long as the other ectoparasitic forms. It, therefore, might have been recovered more often if it had been possible to examine more living moles, or to have obtained and examined the hosts very soon after death.

ENDOPARASITES

*Nematoda*

The roundworm *Physaloptera limbata* Leidy, 1856, was the only nematode found; it was recovered from 6 moles, both males and females being infected. This represented an infection of 14.0% with a mean incidence of 1.3. Never more than two worms were found in a single host.

*Physaloptera limbata* was found only in the stomach. In cases where the worm was still attached, it was usually near the pylorus. These worms had no visible effect on the nutrition of the moles. However, there was evidence of a pathological condition resembling a mild gastritis in the stomach of one animal. There was some ulceration of the stomach wall where a worm had apparently been attached at some previous time. Monnig (1938) observed that *Physaloptera* occasionally change their site of attachment and leave wounds that continue to bleed. The mucosa then may become inflamed with subsequent erosion of the epithelium.

It would seem that secondary invaders might be of serious consequence if a great number of these worms were present.

*Acanthocephala*

The spiney-headed worm *Moniliformis clarki* (Ward 1917) Van Cleave 1924 occurred in 6 males representing both sexes of the host. There was an infection of 14.2%. From 1–10 worms per host were recovered representing a mean incidence of 1.9.

In all the moles *M. clarki* was attached to the mucosa of the small intestine. These worms were located at distances varying from 10 centimeters to 30 centimeters from the pylorus. There was a firm attachment to the intestinal wall, and the head of the worm was always directed anteriorly. The medium surrounding the parasites was semi-liquid, well digested food.

The heaviest parasite burden of this worm was in a mole trapped in the city of Columbus, Ohio. Ten mature worms were attached between 35 to 37 centimeters from the pylorus. Despite the fact that the intestine was distended and partially obstructed by the presence of these worms, there was no evidence of any nutritional or pathological condition in the host. There was, however, a slight mechanical injury caused by the attachment of the hooks of the proboscis.

In general, the incidence with *M. clarki* was greatest in urban areas.

Several specimens of *M. clarki* were sent to Dr. Asa C. Chandler of Rice Institute for verification of the identification.

*Cestoidea*

A single genus of tapeworm, identified as *Hymenolepis* sp., was taken from 2 moles. The percentage of infection was 4.76% with an incidence of 1.4.

In all, only 3 tapeworms were recovered. They were located high in the small intestine. While in each case the scolex of each worm was free from the intestinal

wall, there was no evidence of the worms having migrated. Apparently the tapeworms had become detached from the intestinal wall upon death of the host.

No apparent damage was caused by this tapeworm. Since it is a relatively small worm, its nutritional requirements are undoubtedly negligible. However, it is conceivable that if it were present in large numbers, it might rob the host of sufficient food to produce the type of symptoms associated with tapeworm infection.

## DISCUSSION

The incidence of infection of the 42 moles examined during this investigation is strikingly low as compared with that of other small mammals in this area as shown by Katz, 1938; Ellison, 1942; Koutz, 1944. It is believed that there are two possible explanations for this condition. First, the moles' subterranean habitat forms a mechanical barrier against the parasites of surface dwelling animals and, therefore, the parasites are not shared. Parasite ova voided in the feces of other animals would seldom find their way into the moles' feeding area. Second, earthworms make up the greatest part of the moles' food, (Jackson 1915). Apparently earthworms do not serve as intermediate hosts of parasites of the mole.

Despite the fact that the incidence of infection was low, the percentage of infection was extremely high (97.3%). There was only 1 mole in this survey that was entirely free from parasites. Since this specimen had been dead about 4 hours, it is unlikely that external parasites would have left the body in this length of time. This mole was trapped in an area from which other parasitized moles had been taken, thereby precluding the fact that the area was free of infestation. It would seem that this specimen had failed to contact infective stages of parasites, or, having contacted them, was immune to infection.

Again, since this was an immature mole, the absence of internal parasites might possibly be explained by the fact that the mole may not have been foraging long enough to have acquired an infection.

It is more difficult to explain the absence of ectoparasites, since it is highly probable that they would have been acquired through contact with parasitized moles or from infected nests.

## SUMMARY

1. Six species of parasites were recovered from 42 moles.
   a. The mite, *Atricholelaps glasgowi*, (Ewing). This mite was recovered from 90.4% of the hosts with a mean incidence of 11.4;
   b. The flea, *Ctenophthalmus pseudagyrtes* Baker, 1904. This occurred in 83.3% of the moles with a mean incidence of 7.0;
   c. The beetle, *Leptinus testaceus* Mueller, 1817, was recovered from 4.76% of the hosts with an incidence of 1.5;
   d. The roundworm, *Physaloptera limbata* Leidy, 1856, was recovered from 14.0% of the moles with a mean incidence of 1.3;
   e. The spiney-headed worm, *Moniliformis clarki* (Ward 1917), Van Cleave, 1924. This worm was taken from 14.2% of the moles with a mean incidence of 1.9;
   f. A tapeworm, *Hymenolepis* sp., was recovered from 4.7% of the hosts with an incidence of 1.4.

2. The percentage of infection with all parasites was 97.3% whereas the incidence of infection was 17.3.

3. In general the parasites had little effect on the condition of the host. Only 2 pathological conditions could possibly be attributed to parasitism. These were: (1) a dermatitis probably caused by *A. glasgowi*, and (2) gastritis which may have been caused by the attachment of *P. limbata*.

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# WOLFFIA PAPULIFERA AND LEMNA MINIMA IN OHIO

MAURICE B. WALTERS,

Cleveland, Ohio

In mid-autumn of 1948 and again in the summer of 1949 the writer made collections of one of the Duckweed family which until recently has been considered one of quite rare occurrence—*Wolffia papulifera* Thompson. Both Gray and Britton and Brown cite it as occurring only in Missouri. Muenscher, however, in his Aquatic Plants of the United States, calls it "infrequent in the central states." A recent article in the American Midland Naturalist (Wolffie papulifera in Florida—D. Jacobs, Vol. 42, p. 110), announces its discovery in Florida and refers to it as apparently the only known occurrence outside of Missouri.

However, it has been collected in several other places, as set forth in an article published some years ago, which has just been brought to the writer's attention. In "Distribution and Flowering in Wolffia papulifera," by W. H. Camp, Ohio Journal of Science, Vol. 33, p. 163 (May, 1933) collections are listed from the following stations:

Kennett, Mo.
Columbia, Mo.
Linn Co., Kan.
Mexico City, Mex.
Latonia, Ky.
Jackson Co., Ohio.
Southern Campeche, Mex.

The collections made by the writer were from ponds located in the Holden Arboretum in Lake County; the species was growing in company with *Wolffia columbiana* Karst. and *Spirodala polyrhiza* (L.) Schleid.

Collections were also made at about the same time of another species of the family which is apparently of infrequent occurrence, or what is more likely, generally overlooked—*Lemna minima* Phill. It grew in a stagnant pool near the Chagrin River in Cuyahoga County, the territory comprising a part of the Cleveland Metropolitan Park System. It seems rather remarkable that there is no record to date of this latter species in the Ohio State University Herbarium.

# FIVE NEW ARKANSAS MILLIPEDS OF THE GENERA EURYMERODESMUS AND PARESMUS (XYSTODESMIDAE)

NELL B. CAUSEY
Fayetteville, Arkansas

The Arkansas millipedes described in this paper were collected by the author with the assistance of Dr. David Causey. The Illinois specimen was obtained through the kindness of Dr. Milton W. Sanderson. Holotypes will be desposited in the collection of the Philadelphia Academy of Sciences; paratypes will be retained by the author.

During the summer of 1887 Charles H. Bollman, then a student at the University of Indiana, collected myriapods in Arkansas incidental to his work on the Geological Survey of Arkansas.[1] This work covered the region lying between the Ouachita River near Arkadelphia and the Indian Territory line near Ultima Thule in Sevier County. The specimens which he identified as *Leptodesmus hispidipes* (Wood) and reported as "abundant everywhere . . . very common throughout the state"[2] were undoubtedly various species now assigned to *Eurymerodesmus* and *Paresmus*.

### Genus **Eurymerodesmus** Brölemann

Tergites smooth. Keels moderately extended, their margins thickened, anterior angles rounded, posterior angles from rounded to subacute, pores lateral. Femora of legs not spined. Gonopods small, telopodite a single unbranched slender blade with setae usually in rows. Margin of gonopodal opening variously modified posteriorly and laterally with setose lobes. The genotype is *E. hispidipes* (Wood).

### **Eurymerodesmus hispidipes** (Wood)

Figures 1–4

*Polydesmus hispidipes* Wood. Proc. Phila. Acad. Sci., 1864, p. 7; Trans. Amer. Phil. Soc., 1865, p. 220, fig. 48.
*Leptodesmus hispidipes* Bollman. Ent. Amer. IV, 1888, p. 2.
*Eurymerodesmus hispidipes* Brölemann. Mem. Soc. Zool. Fr., XIII, 1900, p. 101, pl. 6, fig. 32.

In a collection of several hundred millipedes made by the Illinois Biological Survey, there was only one specimen of *Eurymerodesmus hispidipes*. Such relative scarcity in the type state makes publication of additional details of this species seem desirable. Wood's (1865) description is as follows:

"Olive-brown, immaculate; anal scutum triangular, with long hairs; apex truncate and decurvate; feet roughly hairy; male appendages short, robust; their terminal spine moderate, distally abruptly curvate, densely pilose.

"The side plates are rather short, with their edges much thickened. The head has its vertex strongly caniculate. Its anterior face is marked with two small punctiform impressions. The lower border is not very strongly emarginate, and is set with a fringe of short thick hairs. The antennae are mostly dark-colored, scarcely at all clavate, and coarsely pubescent. The feet are rough, with closely set, stiff hairs. The anal scutum is prolonged posteriorly, so as to come almost to a blunt point. The appendages of the male are short and thick. Their terminal spine is slightly curved at its base, thence is nearly straight, save at its distal extremity, where it is abruptly curved, becoming nearly horizontal. It is beset with very numerous long hairs. . . . The female appendages consist of a pair of short, conoidal, very pilose processes, which have an opening along their inner edge. Length, 1⅛ inches.

"Hab. Illinois."

Although my specimen is faded, there are indications of the usual mid-dorsal black line and the colored, probably orange, keels and margins around the collum and on the posterior edges

[1]Ann. Rep. Geol. Sur. Ark. 1888.
[2]Bull. U. S. Nat. Mus. 1893, No. 3, p. 74.

of the tergites. The olive pigment extends down the sides under the keels in triangular areas almost to the sternum. The legs are darker distally. Antennal joints are edged in black.

The process on the mandibular stipe has a longitudinal ridge on the anterior surface and an oblique ridge ectad. Distally it is flattened and pigmented (Fig. 1).

The coxal joint on the second pair of legs is unusual in that the anterior of the two conical tubercles is about twice as long as that observed in any other species; the posterior is the usual size (Fig. 2).

Between the fourth, fifth, and sixth pairs of legs there are low, rounded, hirsute prominences. The sternal processes between the eighth legs are shown in Fig. 3. Similar but smaller processes are between the seventh legs. The claws of the legs have a bulbous process at the base.

In *situ* the telopodites of the gonopods lie parallel, the laterally pointing apices accuminate and slightly flattened. Setae occur in three rows: a short subterminal medial row and long lateral and ventral rows.

The gonopodal opening is broadly oval, emarginate as usual anteriorly, and with a row of long stiff setae on the anterior margin. A pair of conspicuous quadrate lobes is set obliquely near the latero-posterior angles of the opening (Fig. 4). The lobes are raised about half the height of the first joint of the eighth pair of legs, bear a few setae on their inner or posterior surfaces, longer setae on the highest margin, and numerous setae on the anterior or lateral surfaces. Similar lobes occur in *E. spectabilis*, *E. bentonus*, and *E. minimus* Loomis.[3]

Length of male about 30 mm., width 4.2 mm.

Locality: Illinois, Dixon Springs. Collected by Mr. Phillip W. Smith, April 3, 1948.

**Eurymerodesmus bentonus,** n. sp.

Figure 5

Tergites dark olive with mid-dorsal black line, orange keels and orange bands of almost uniform width around collum and across posterior margins of tergites. Anal tergite orange distally. Antennae, lengs, and venter cream. Dark triangular areas extend down the sides of the prozonites almost to the legs; similar areas are shorter on the metazonites.

Lateral margins of keels almost straight; posterior angles of fourteenth through nineteenth acute. This is in contrast to *E. hispidipes*, where the keels are well rounded laterally and the posterior angles of only the seventeenth through the nineteenth are acute. This alone makes *bentonus* easily distinguished from *hispidipes*.

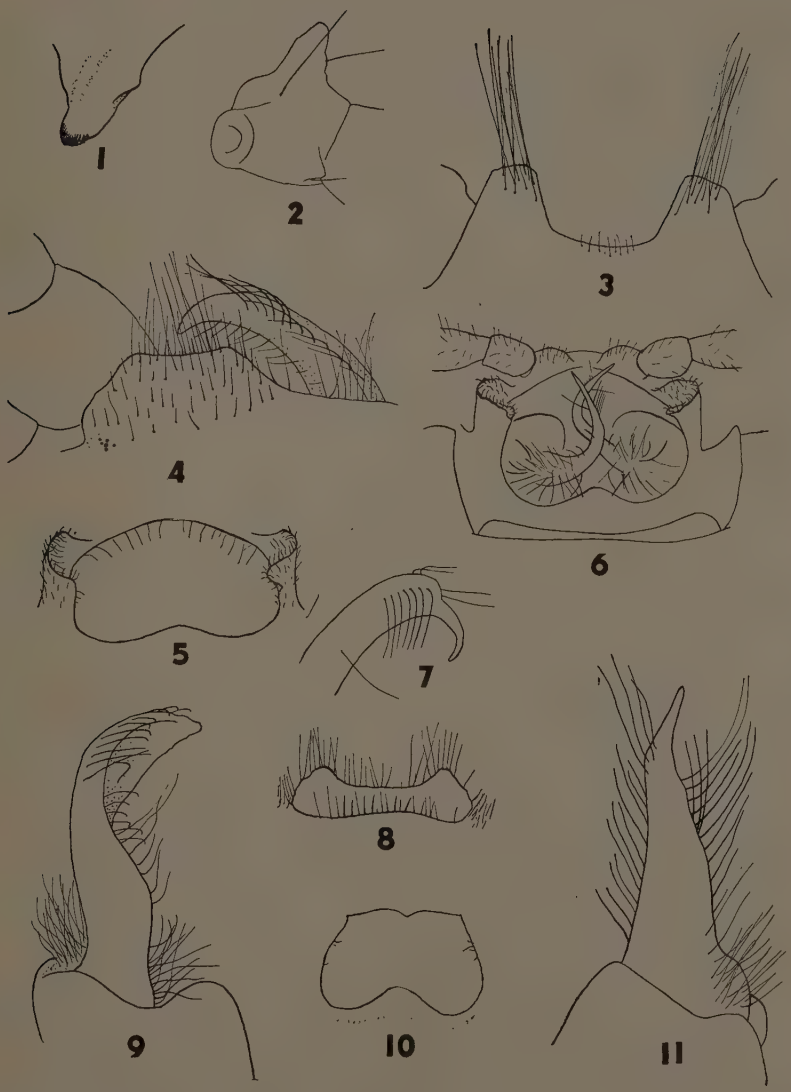
Process on mandibular stipe of male about half as large as in *hispidipes*, but slightly pigmented, and without ridges.

Coxal joint on second legs of male with the usual two conical tubercles, the anterior scarcely larger than the posterior. Legs and sterna are less hirsute than in *hispidipes*. Claws of male

[3]Loomis, H. F. 1943, Jour. Wash. Acad. Sci. XXXIII, no. 10, p. 320, fig. 2.

## EXPLANATION OF FIGURES

FIG. 1. *Eurymerodesmus hispidipes* (Wood). Mandibular process, left, anterior view, × 40.
FIG. 2. *Eurymerodesmus hispidipes* (Wood). Coxa of left second leg, ventral view.
FIG. 3. *Eurymerodesmus hispidipes* (Wood). Sternal processes between eighth legs of male, posterior view.
FIG. 4. *Eurymerodesmus hispidipes* (Wood). Telopodite of male gonopod, lobe of gonopodal opening, base of eighth leg, left side, anterio-lateral view.
FIG. 5. *Eurymerodesmus bentonus*, n. sp. Gonopodal opening (gonopods omitted), anterio-ventral view.
FIG. 6. *Eurymerodesmus spectabilis*, n. sp. Seventh segment, anterio-ventral view.
FIG. 7. *Eurymerodesmus spectabilis*, n. sp. End of left telopodite, ectal view.
FIG. 8. *Eurymerodesmus plishneri*, n. sp. Gonopodal opening (gonopods omitted), anterior view.
FIG. 9. *Paresmus pulaski*, n. sp. Right gonopod, ventro-lateral view.
FIG. 10. *Paresmus columbus*, n. sp. Gonopodal opening (gonopods omitted), ventral view.
FIG. 11. *Paresmus columbus*, n. sp. Right gonopod, ventral view *in situ*.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finer and without the large bulbous base as in *hispidipes*. Small hirsute prominences occur between the bases of legs four through seven. The processes on the sternum between the eighth legs are not as high or as widely separated as in *hispidipes*.

Gonopodal opening broadly oval, slightly emarginate anteriorly (Fig. 5). No setae occur on the anterior margin, but they are present posteriorly and on the marginal lobes. The lobes are quadrate as in *hispidipes*, but they are nearer the margin and the highest point is the anterior corner. Setae occur on the anterior and posterior surfaces of the lobes; they are shorter than the setae on the lobes of *hispidipes*. In *hispidipes* the setae on the free edge are long, tending to give the lobe a triangular rather than a quadrate appearance.

Telopodite of gonopod simple, curved sharply distally. The acute amber tip projects slightly beyond the posterior margin of the gonopodal opening. *In situ* the telopodites of some males are parallel, in others they are crossed and subparallel. As in *hispidipes* there are three rows of setae on the telopodite: a short subterminal medial row and two long rows, one lateral and the other ventral.

Length of male holotype, 33 mm.; width 4.4 mm. Length of female allotype, 26 mm., width 4.2 mm. An intersex in the type collection was 27 mm. long and 4 mm. wide; it had secondary sex characteristics of the female; vulvae, gonopods, and gonopodal opening appeared normal.

Locality: Arkansas, Benton County, Monte Ne. One male, two females, and the intersex were collected November 19, 1949, at the base of a north sloping hillside on which oaks predominated. Numerous other specimens were collected with *E. plishneri* at Blue Spring, Carroll County, Arkansas, October 29, 1949. This site is also hardwood, predominantly oak.

**Eurymerodesmus spectabilis,** n. sp.

Figures 6 and 7

Tergites black and beige mottled, some specimens black and orange; the latter probably is the mature color; prozonites usually darker than metazonites. Intermittent mid-dorsal black line. Entire margin of collum, the keels, and distal part of twentieth segment orange. Some specimens have an irregular orange band which does not reach the keels on the posterior region of the tergites; in some specimens the orange band is replaced by four orange spots; in some the color is so intense that at a distance they appear to be orange. Antennae tan, the sixth segment darkest. Distal half of legs, anal valves, and scutum, and sides of body dark mottled. The mottled pigment extends far down near the attachment of the legs on the metazonites but less far on the prozonites. Venter and proximal half of legs cream.

Keels slightly rounded laterally, but less so than in *hispidipes*; posterior angles of fourteenth through nineteenth acute.

Process on mandibular stipe less than half as long as in *hispidipes*; not pigmented.

Coxal joint of second legs of male without the usual two conical tubercles. Female very sparsely hirsute ventrally; male much less hirsute ventrally than in *hispidipes*. Claws of male heavy and somewhat twisted, the bulbous base not conspicuous. Processes on the sternum between the eighth legs not as high or as widely separated as in *hispidipes*. Sterna of legs three through seven without special processes.

Gonopodal opening typically emarginate anteriorly and almost free of setae; posteriorly the margin is difficult to determine since the opening reaches far back to the eighth sternum; quadrate lobes arise from the posterio-lateral margins, flare widely, and end behind the margin near the eighth legs; their anterior corners are sharp and the anterior edges are folded back; the free edges behind the anterior corners are black, and short recurved setae occur on the edges and the medial surfaces (Fig. 6).

Telopodite of gonopod simple, sickle shaped; end abruptly accuminate, giving it a beak-like appearance (Fig. 7), two sparse rows of setae, most of them on distal half of telopodite.

Length of male holotype, 21 mm., width 3 mm. Length of female allotype, 22 mm., width 3.2 mm.

Locality: Arkansas, three miles east of Magnolia in a climax pine-hardwood area. Three males and six females were collected Dec. 24, 1949.

**Eurymerodesmus plishneri,** n. sp.

Figure 8

Adults in full color with gray-brown tergites, intermittent mid-dorsal black line. Keels, margin of collum, posterior margins of tergites, and distal part of twentieth tergite orange. Orange margins on tergites usually wider medially, almost giving the animal a trimaculate appearance, and causing it to resemble *Autarus florus*, with which it is usually found. Antennae and distal half of legs dark gray. Underparts and proximal half of legs cream. Brown pigment extends far down sides, almost to attachment of legs.

Lateral margins of anterior and middle keels rounded, but not as much as in *hispidipes*; posterior angles of sixteenth through nineteenth acute.

Process on mandibular stipe about size and shape of that in *hispidipes*, but without ridges or pigmentation.

Coxal joint of second legs of male with the usual two conical tubercles, about equal in size and not conspicuous. Claws of male thick, not twisted, but with bulbous base. Sternal processes between eighth legs of male with space between them about equal to width of one of the processes inverted; with long setae. Sterna between legs four through seven setose, lightly rounded; remaining sterna between legs of male moderately setose. Sterna of female almost glabrous.

Gonopodal opening emarginate anteriorly and slightly emarginate posteriorly. The margin bears posteriorly a pair of widely separated triangular lobes; similar lobes occur in *E. birdi* Chamberlin, but the illustration given for that species[4] shows the lobes sharper and closer together than in *plishneri*. The elevation of the margins is shown in Fig. 8. The row of long setae across the anterior margin of the opening makes *plishneri* easily distinguished from *E. bentonus*, whose range it overlaps. Setae are seen laterally on the margin, which is pigmented there, and out on the sternum. Setae also occur on the margin of the lobes, on their posterior surface, and on the margin between the lobes.

Telopodite of gonopods of male simple, curved gently proximally and sharply distally. Its setae are in three rows: a short subterminal row of four or five setae, and two rows which extend almost the full length of the telopodite; the dorsal of these two rows is sparser.

Length of male holotype, 29 mm., width 4.2 mm. Length of female allotype, 29 mm., width 4.4 mm.

Locality: Arkansas, Mount Kessler, Fayetteville, November 10, 1949. Other collection sites in Washington County are Devil's Den State Park, Mount Sequoyah, Elkins, and Eden's Bluff. Blue Spring in Carroll County. Oaks are dominant at all sites.

I take pleasure in naming this species for Mr. M. J. Plishner, National Tuberculosis Association, in recognition of his assistance.

Genus **Paresmus** Chamberlin[5]

Agreeing in general with *Eurymerodesmus*. The gonopods of the male are stouter throughout. Lobes of gonopodal opening are continuous with margin, not flaring widely laterally or between the legs as in *Eurymerodesmus*.

**Paresmus pulaski,** n. sp.

Figure 9

Tergites dark olive with indistinct mid-dorsal black line; prozonites darker than metazonites. Keels and distal part of anal tergite orange; entire margin of collum and posterior margin of tergites orange. On most of the metazonites the orange area is wider medially, narrower laterally, resulting in almost a trimaculate appearance. Legs dark distally; some spots of the dark pigment also on the sterna and proximal region of the legs, which otherwise are cream. Sides well mottled with pigment. Antennae tan except for sixth segment, which is brown.

[4]Chamberlin, R. V. Ent. News, 1931, XLII, no. 4, pp. 101–102, fig. 8.

[5]Chamberlin, R. V. Bull. Univ. Utah, vol. 32, no. 8, p. 7, figs. 18 and 19.

Lateral margins of keels rounded, but not as much as in *hispidipes*; posterior angles of fourteenth through nineteenth acute.

Process on mandibular stipe of male about one-fourth longer than in *hispidipes*; laterad surface with low, broad prominence near base; no dark pigment.

Coxal joint of second legs of male with the usual two conical tubercles, both rather sharp, but shorter than the genital process. Coxae of the third and fourth legs have a conical tubercle similar in shape and position to the anterior tubercle on the coxae of the second legs. Sterna between the legs of male hirsute. Sternal processes between the eight legs are triangular, with relatively few setae, and widely separated. Low, setose processes also occur between the legs of the fifth and sixth segments. Claws not twisted.

Gonopodal opening sharply emarginate anteriorly and broadly oval posteriorly. When viewed laterally, the margin rises from its lowest point on the anterior margin to a triangular lobe laterally, falls somewhat and then rises to another small triangular lobe near the base of the eighth leg. The lobes are continuous with the margin and are not apparent as lobes when viewed ventrally. All of the margin except the anterior is setose, and the lobes are setose on their outer surfaces.

Male gonopods relatively large. *In situ* the telopodites cross proximally, then continue parallel, their dorsally curved ends reaching beyond and resting in the depression between the sternal processes between the eighth legs. The ventral surface of the telopodite is convex; dorsally it is concave and there is a subterminal tooth on the dorsal surface (Fig. 8); the distal third is bright amber color. Setae occur in two rows on the telopodite: one on the dorsal surface running almost the full length, and the other latero-ventral (*in situ*) on the distal half.

Length of male holotype, 38 mm., width 6 mm.

Locality: Arkansas, Pulaski County, three miles south of Sweet Home. Two males were collected December 22, 1949, in an oak-pine association.

**Paresmus columbus,** n. sp.

Figures 10 and 11

In color, pattern, and shape of keels similar to *P. pulaski*. Process on mandibular stipe without prominence at base; light brown.

Coxal joint of second legs of male with the usual two conical tubercles, both rather sharp and slightly shorter than the genital process, which is somewhat truncated in this species. Small sternal setose processes are between the bases of all the legs from the fourth through the tenth; those between the eighth legs are largest, and the excavation between them is narrow, about half the width of one of the processes. Sterna of female almost glabrous.

Gonopodal opening emarginate both anteriorly and posteriorly and angular posterio-laterally (Fig. 10). When viewed laterally the margin rises from its lowest point anteriorly to a triangular lobe laterally; the highest point of the margin is just anterior to the posterio-lateral angle of the gonopodal opening. As in *P. pulaski* the lobes are continuous with the margin and are not apparent as lobes when viewed ventrally. The lobes are sparsely setose on their margins and lateral surfaces; their margins are pigmented. The anterior and posterior margins of the gonopodal opening are glabrous.

Male gonopods with the usual large coxa and small telopodite; telopodite broad at base, accuminate distally, the tip curving dorsally (Fig. 11) and overlapping. Two long rows of setae distinguish this from the telopodite of *E. creolus* Chamberlin.[6] A longitudinal ridge is on the dorsal surface.

Length of male holotype, 35 mm., width 5.2 mm. Length of female allotype, 32 mm., width 5.3 mm.

Locality: Arkansas, three miles east of Magnolia in a climax pine-hardwood area. Two males, two females, and several larvae of the sixth and seventh stadia were collected December 24, 1949. *E. spectabilis* occurred at the same site.

[6]Chamberlin, R. V. 1942, Bull. Uni. Utah, vol. 32, no. 8, p. 6, fig. 16.

# EFFECT OF TEMPERATURE ON CATALASE ACTIVITY

H. C. EYSTER
The Charles F. Kettering Foundation,
Yellow Springs, Ohio

A search of the literature for an enzyme already quite well known which might be involved directly or indirectly in photosynthetic reactions suggested catalase. Catalase occurs in chloroplasts (Neish, Krossing), its activity in light grown corn seedlings is greater in green ones than in albino or in yellow ones (Eyster, 1950) and it is heat sensitive at much below the boiling point of water and at a temperature which it was thought might possibly explain the maximum temperature for photosynthesis.

Leaves exposed for one minute at 55° C. and above lost the ability both to form chlorophyll and to transform sugar into starch (Eyster, 1949). It was therefore of interest to study the thermal stability of catalase, and to determine the critical temperature at and above which destruction of catalase in corn seedling leaves occurs.

## METHODS AND MATERIALS

Green and etiolated corn seedlings were grown and were subjected to a series of temperatures by means of a water bath. The temperatures employed were 50°C, 55°C, 60°C and 65°C, respectively. These temperatures were rigidly maintained within 1°C. The seedlings, about 14 days old, were cut off at the base, inverted and submerged in the water of the water bath for periods of 1 minute, 5 minutes, 10 minutes and 30 minutes, respectively.

Catalase activity was determined by the "catalase tube" method of Knott (1925) who measured the oxygen evolved from $H_2O_2$ at a constant temperature and with constant shaking for a 5-minute interval on one gram of macerated tissue. The temperature of the water bath was 27.5°C ± 0.5, and the catalase tube was shaken at a constant frequency of 140 revolutions per minute. The motor driven apparatus was improved by replacing the leather belt with chain and gears. This eliminated all variations due to slippage, and standardized the shaking considerably. Present too, were an ammeter and a voltmeter to measure electric D.C. current feeding into the motor. A rheostat was installed to regulate the current and thus have the motor maintain a constant speed of 140 r.p.m.

The sample was prepared by taking 1 gm. of umblemished fresh leaves. These were cut with scissors, disregarding size and shape, and placed in small mortar. To this was added 1 gm. U.S.P. precipitated $CaCO_3$, approximately 1 gm. reagent grade sea sand 60–120 mesh, and 1–2 ml. distilled water, depending upon dryness of sample. The mixture was ground to a fine paste (for about 7 minutes) using large pestle. This was washed with distilled $H_2O$ into a small bottle. The total volume of water added was 25 ml. This was found to be a most convenient amount for rinsing mortar and pestle.

After shaking the mixture, 2 ml. portion was quickly withdrawn by use of a large orifice pipette and transferred to one arm of catalase tube. Five per cent hydrogen peroxide was used to which some $CaCO_3$ had been added and shaken. This mixture was kept stoppered and standing in ice water to keep the $H_2O_2$ at constant concentration by reducing decomposition to a minimum. 2 ml. of this was withdrawn by pipette and placed into the other arm of catalase tube. To get checks the ends did not need to be the same for sample and for $H_2O_2$ respectively. The charged catalase tube was carefully secured (level and in line with rod) to stopper on shaft and allowed to sit in the bath exactly 3 minutes to come to temperature of bath. Meanwhile water level in gas burette was adjusted and air exit

clamped. It was made certain that the catalase tube would fit well up on the stopper. The motor and stopwatch were started simultaneously. The gas burette reading was taken immediately at end of 5 minutes by adjusting the water level during the run.

## RESULTS AND DISCUSSION

The catalase measurements are given in Tables I and II. Table III is a summary of Tables I and II. A study of the data in these tables will reveal that 55°C was the temperature at and above which destruction of catalase occurred.

TABLE I

CATALASE MEASUREMENTS ON ETIOLATED CORN SEEDLINGS SUBJECTED TO TEMPERATURES BETWEEN 50°C AND 65°C FOR PERIODS VARYING FROM ONE MIN. TO THIRTY MIN.
Catalase value is expressed as ml. of $O_2$ in a 5-minute interval.

| | CATALASE ACTIVITY AFTER: | | | | |
|---|---|---|---|---|---|
| Temperature | 1 min. | 5 min. | 10 min. | 30 min. | Controls |
| 50° C. | 9.20 | 9.22 | 9.10 | 8.80 | 9.22 |
| | 9.30 | 9.15 | 9.00 | 8.80 | 9.20 |
| | 9.20 | 9.20 | 9.10 | 8.80 | 9.28 |
| Average | 9.23* | 9.19* | 9.07* | 8.80* | 9.23* |
| 55° C. | 8.70 | 8.42 | 8.20 | 1.95 | 8.28 |
| | 8.60 | 8.42 | 8.18 | 1.98 | 8.30 |
| | 8.60 | 8.40 | 8.22 | 2.02 | 8.28 |
| Average | 8.63* | 8.41* | 8.20* | 1.98** | 8.29** |
| 60° C. | 7.10 | 0.80 | | | |
| | 7.08 | 0.72 | | | |
| | 7.02 | 0.75 | | | |
| Average | 7.07** | 0.76** | | | |
| 65° C. | 0.60 | | | | |
| | 0.60 | | | | |
| | 0.60 | | | | |
| Average | 0.60** | | | | |

*Denotes comparability with proper control.

A pretreatment of seedlings at 55°C for one minute brought about some destruction. At 50° C there was no significant destruction except for pretreatment of green seedlings for 30 minutes. A comparison of the temperature effects on etiolated and green seedlings of approximately same age showed the catalase in green ones to be slightly the more heat-labile or destructible.

Why is it that 55°C is the critical temperature above which chloroplast catalase is destroyed as well as above which chloroplasts lose their ability both to form chlorophyll and to transform sugar into starch? There are at least two plausible explanations. Either (1) all of the chloroplast reactions are intimately tied up so that a disturbance to one affects the others also, or (2) the various chloroplast reactions are accomplished by independent proteinaceous enzymes which are denatured by much the same conditions.

Lantz (1927) reported that drying of corn seedlings at a temperature of 56°C reduced their catalase content, and that a continuous temperature of 42°C during

germination and growth decreased markedly the catalase content of corn seedlings. In the potato tuber, Appleman (1910) found that the catalase was completely destroyed at 50°C. The point of total destruction of catalase for most of the cases reported, however, ranges from 65 to 80°C (Miller, 1938).

It is well known that low temperature interfers with the utilization of nitrogen compounds and accounts for chlorosis in corn germinating on cool spring days. To determine whether catalase formation may also be markedly reduced by low temperature during early growth of corn seedlings, the thermostat of the greenhouse was adjusted to maintain a temperature of 10°C. This was done just as the green seedlings were pushing through the surface of the soil. After 10 days

TABLE II

CATALASE MEASUREMENTS ON GREEN CORN SEEDLINGS SUBJECTED TO TEMPERATURES BETWEEN 50°C AND 60°C FOR PERIODS VARYING FROM ONE MINUTE TO THIRTY MINUTES.
Catalase value is expressed as ml. of $O_2$ in a 5-minute interval.

| Temperature | CATALASE ACTIVITY AFTER: | | | | |
|---|---|---|---|---|---|
| | 1 min. | 5 min. | 10 min. | 30 min. | Controls |
| 50° C. | 8.80 | 8.75 | 9.85 | 7.95 | 8.60 |
| | 8.72 | 8.68 | 9.80 | 8.00 | 8.52 |
| | 8.75 | 8.52 | 9.72 | 7.90 | 8.45 |
| | .... | 8.58 | .... | .... | .... |
| Average | 8.76* | 8.63* | 9.79** | 7.95** | 8.52* |
| 55° C. | 9.52 | 7.55 | 4.30 | 1.02 | 10.20 |
| | 9.35 | 7.70 | 4.40 | 1.12 | 10.12 |
| | 9.28 | 7.72 | 4.30 | 1.05 | 10.20 |
| Average | 9.38** | 7.66*** | 4.33*** | 1.06**** | 10.17** |
| 60° C. | 2.90 | .... | .... | .... | 10.02 |
| | 2.90 | .... | .... | .... | 10.25 |
| | 2.88 | .... | .... | .... | 10.02 |
| Average | 2.89**** | .... | .... | .... | 10.02*** |
| | | | | | .10 |
| | | | | | 8.92 |
| | | | | | 8.88 |
| | | | | | 8.72 |
| | | | | | 8.84**** |

* Denotes comparability with proper control.

time four pots of these corn seedlings were removed to a place indoors where the temperature was 25°C and where there was constant artificial illumination (15 ft. candles). At this time the corn seedlings were 5–6 cm. tall and were quite yellow in appearance. The chlorophyll content remained quite low in ones remaining at 10°C, but the ones removed to 25°C became quite green in about one day. The catalase activity (Table IV) was found to be quite high in the chlorotic ones grown at the low temperature, but did increase somewhat in the ones placed at 25°C. These results are in general agreement with Lantz (1927) who found that there was a gradual accumulation of catalase in corn germinating and growing at 10° C, so that in 30 days the catalase content was nearly equal to that at 20 to 30°C.

While there is a remarkably close correlation in the way physical factors and chemical compounds affect catalase activity and photosynthesis, there is still no proof that the two are directly connected by a functional relationship.

TABLE III

SUMMARY OF EFFECT OF TEMPERATURE TREATMENTS ON CATALASE ACTIVITY, BASED ON CONTROL=100

| *Etiolated* | | | | |
|---|---|---|---|---|
| Temperature | CATALASE ACTIVITY AFTER: | | | |
| | 1 min. | 5 min. | 10 min. | 30 min. |
| 50° C. | 100 | 100 | 99 | 95 |
| 55° C. | 93.5 | 91 | 89 | 24 |
| 60° C. | 85 | 9 | | |
| 65° C. | 7 | | | |
| *Green* | | | | |
| Temperature | 1 min. | 5 min. | 10 min. | 30 min. |
| 50° C. | 103 | 101 | 96 | 78 |
| 55° C. | 92 | 76 | 43 | 12 |
| 60° C. | 33 | | | |

TABLE IV

EFFECT OF TEMPERATURE DURING GROWING PERIOD ON CATALASE ACTIVITY

Catalase value is expressed as milliliters of $O_2$ in a 5-minute interval.

| AGE OF SEEDLINGS | CATALASE ACTIVITY | |
|---|---|---|
| | Greenhouse 10° C. | In Doors 25° C. |
| *Days* | | |
| 14 | 9.25 (2) | ..... |
| 15 | 9.12 (2) | 11.68 (2) |
| 16 | 8.44 (2) | 10.27 (2) |
| 17 | 9.57 (2) | 10.94 (2) |

SUMMARY

1. Catalase in leaves of corn seedlings was destroyed by temperatures at or above 55°C.

2. A comparison of the temperature effects on etiolated and green seedlings of approximately the same age showed the catalase in green ones to be slightly the more heat-labile or destructible.

3. There seems to be a common thermal effect on catalase, starch synthesis enzyme, and chlorophyll synthesis enzyme. 55°C is the critical temperature above which all three enzymes are destroyed. A plausible explanation for this enzymatic destruction is that these enzymes are proteinaceous and are subject to thermal denaturation, as for example, egg albumin.

4. The catalase activity was found to be quite high in chlorotic corn seedlings grown in greenhouse at 10°C, but did increase somewhat in ones placed at 25°C.

5. There may be no direct functional connection between catalase activity and photosynthesis.

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# OCCURRENCE OF SCAPHIOPUS HOLBROOKII HOLBROOKII (HARLAN) IN ATHENS COUNTY, OHIO[1]

PAUL J. SPANGLER

Department of Zoology, Ohio University,
Athens, Ohio

A single individual of the spadefoot toad was collected near Athens, Ohio, May 24, 1943, by Dr. H. T. Gier. This specimen, an adult female, was reported in Copeia.[2] This appears to be the only definite record for Ohio up to the present.

Following a heavy rainstorm on June 1, 1950, Jack Jacobsen and the author heard an unfamiliar "whank" coming from a temporary pond near the Athens Airport. We investigated the area and were able to collect one female specimen which was swimming in the water. Others were heard but could not be located.

On June 16, following another heavy rainstorm, the toads were again heard. The temporary pond near the airfield was examined again, and several males were spotted singing. They submerged when approached and none were collected. At another temporary pond at the western end of the airfield a terrific din was set up by these toads. By using a net, thirty-one (31) specimens were collected in less than half an hour. There were many more present in the pond. Eight pairs were taken in amplexus. Tadpoles of the toads were also collected on June 29. These are the first tadpoles of the spadefoot collected in Ohio. Specimens will be placed in the Zoology Department Collections at Ohio University, Athens, and in the Ohio State Museum, Columbus.

Specimens: 1 ♀—Near Athens, Ohio, May 24, 1943, H. T. Gier, Coll;
1 ♀—Athens (Airport), Ohio, June 1, 1950, Jacobsen & Spangler.
8 ♂ 23 ♀—Athens (Airport), Ohio, June 16, 1950, Spangler.
24 Tadpoles—Athens (Airport), Ohio, June 29, 1950, Spangler.

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[1]Paper No. 48 from the Department of Zoology, Ohio University, Athens, Ohio.

[2]Gier, H. T. Copeia, 1945, (1) p. 50.

# IS NATURAL SELECTION AN OUTWORN TERM?

PAUL D. HARWOOD
Dr. Hess and Clark, Inc.
Ashland, Ohio

In the *Origin of Species* Darwin remarked that it was necessary to use such terms as natural selection and the struggle for existence in "a large and metaphorical sense including dependence of one being on another, and including (which is more important) not only the life of the individual, but success in leaving progeny." (Darwin 19–? p. 78). Some believed that these usages implied too much, but Darwin hoped that with a little familiarity such superficial objections will be forgotten, since "Everyone knows what is meant and is implied by such metaphorical expressions" (p. 99 ibid.).

Notwithstanding his sanguine hopes, antagonism to the phrase, natural selection, still finds expression in scientific journals (McAtee, 1949). Consequently, there may be some excuse for describing briefly a few recent experiences which validate the use of natural selection or survival of the fittest in the Darwinian sense. I do not propose a complete discussion of the subject, indeed completeness is not possible in view of the writer's limited opportunities. Rather I shall describe briefly some observations which validate the concept of natural selection as Darwin employed the phrase. I have already taken some pains to establish the breadth of Darwin's concepts. Another quotation from the *Origin of Species* clearly indicates the core of the definition as employed by Darwin.

"On the other hand, we may feel sure that any variation in the least degree injurious would be rigidly destroyed. This preservation of favorable individual differences and variations, and the destruction of those which are injurious, I have called Natural Selection, or the Survival of the Fittest. Variations neither useful nor injurious would not be affected by natural selection."

It is a fundamental law of life to vary. Zooolgists who have used chemicals experimentally to destroy insects and other forms of life quickly discover that a similar or identical dose yields variable results against different individuals of the same species. Prior to the use of DDT as an insecticide, the innate variations in resistance which houseflies, *Musca domestica*, might exhibit toward the compound doubtlessly existed but were neither useful nor injurious. When that chemical was first used, variations which are well known were encountered. Therefore, houseflies offered abundant material to test natural selection as soon as DDT became a part of their usual environment. Entomologists of Orlando, Florida, were able to breed highly resistant flies by experimental breeding in the laboratory, and artificial selection of the more resistant individuals. These selected houseflies could withstand successfully much larger dosages of DDT than required to kill their ancestors (Lindquist and Wilson, 1948). Experimentally the efficacy of selection was demonstrated.

Notwithstanding the innate variability of houseflies toward the toxicity of DDT, that chemical was widely used to control the pests. Suddenly the variations became of tremendous significance for the survival of the species. For two or three years many American homes enjoyed practically fly-free summers. But natural selection was approximately as successful among wild flies as experimental selection proved to be in the Orlando laboratory. Particularly in southern California, where a large number of generations per year are possible, DDT resistant flies appeared. At Bellflower, California, a strain of flies was found which required 300 times as much DDT to kill them as normal flies (March and Metcalf, 1949), and the resistance was inherited as proved by breeding tests. The same phenomena was observed in widely separated parts of this country. As yet DDT resistance

among houseflies is not known in Canada, possibly because of the short Canadian summer which does not permit as many generations per year. Consequently, fewer Canadian flies have been exposed to DDT, and natural selection has only a reduced opportunity to exhibit its power.

The case of the housefly and DDT-resistance is only one of many instances in which insects exposed in their natural state to a deleterious chemical have succumbed at first, but after several generations experience, they have developed resistance toward the chemical and have successfully returned near to their former abundance. The individuals with variations tending toward chemical susceptibility were destroyed and the resistant forms were preserved. Perhaps Darwin made an unfortunate choice when he inserted the word "rigid" in the first sentence of the last quotation, but this is largely a question of semantics rather than biology. Certainly under a state of nature, selection has proved far more efficacious than many of us believed possible, and it seems fully as powerful as Darwin expected. The results which are established by laboratory test and by numerous field observations conform closely to the Darwinian theory.

A review of all instances where insects have acquired resistance to insecticides is unnecessary for purposes of this note. However, the fever ticks of cattle, *Boophilus* spp. illustrate some points not apparent in the instance of the housefly and DDT. The U. S. Bureau of Animal Industry recommended the extermination of this tick in 1905 and later conducted a campaign intended to achieve the objective (Report of the Chief of the Bureau of Animal Industry 1905 and subsequently). As McAtee (1949) indicates, the elimination of the last tick proved difficult, but the Bureau persisted. After more than forty years of effort the tick was eliminated from Continental United States, and the campaign was carried to outlying possessions.

In other countries a policy of voluntary control was inaugurated. Infested cattle were dipped in the same arsenical solutions employed for eradication in the United States, but when the numbers of ticks were forced below levels of economic significance dipping ceased. Whereas these arsenical dips used intensively over small area after small area exterminated the tick bit by bit, the same dips used extensively over large areas like Australia and South Africa gradually lost their efficacy (Whitnall and Brackford, 1947; 19th Ann. Rept., 1945 Australia). Today in those countries where control rather than eradication was practiced, arsenic-resistent fever ticks are spreading rapidly, and cattlemen are turning to other agents to stop the successful recrudescence of the fever tick. Where small numbers could be successfully exterminated by arsenical dips, large numbers and several generations through natural selection successfully resisted the same agent.

Possibly the purist may insist that exposure of insects in a state of nature to insecticides is an artificial situation, and therefore, the phrase, natural selection, cannot be applied. Nevertheless, the situation closely parallels some of the hypothetical examples described by Darwin. Consequently, the results observed have some importance as a verification of Darwinism. Using a broad but scarcely metaphorical definition we have seen natural selection operate.

Only small organisms having several generations per year are able to expose a sufficient number of generations and of individuals to a deleterious factor to make possible a successful response. Even with small animals as we have seen, a successful response may not be achieved if the agent is applied to small segments intensively and successively. Furthermore, only economically important species like houseflies and cattle ticks are observed sufficiently closely over long periods of time, and over wide expanses of territory to ascertain if a successful response is being made. Nevertheless, the first stages of this cycle are apparent all about us among other organisms.

A few decades ago, a blight of chestnuts was accidentally introduced into the United States. I was able to observe the effects of this parasite upon a magnificent and virgin stand of chestnuts in the Great Smoky Mountains during the summer of

1947. For hours I walked through a tangle of dog hobble and blackberries. All around were large, dead chestnut trees, some prostrate, others still standing. The trunk of one prostrate giant which lay across the trail was more than breast high; and after climbing onto it, I estimated by pacing that it was more than 60 feet to the lowest limb. Along the trail I saw a very few infected but living individuals. Most were mere suckers from surviving roots, but one was a tree with a trunk more than a foot in diameter. Dead limbs and other lesions proved the tree was infected, yet burrs from the fall before littered the ground. As McAtee states, it is difficult to exterminate the last survivor of a race. Perhaps, after a passage of sufficient time a blight resistant chestnut will repopulate the steep slopes of the Great Smokies, but for a slow breeding organism, like the chestnut, sufficient time means centuries, not a few years as with houseflies.

Meanwhile we can only hope that the status of the chestnut will some day change from that of an unsuccessful, declining population to a successful, increasing species. Nevertheless, we fear the worst. We remember the great hordes of passenger pigeons, which formerly darkened American skies. Whether the last survivors were destroyed by a natural predator, namely man, or whether, as a parasitologist suspects, an introduced pathogen, *Trichomonas gallinae*, finished the work begun by man is unimportant. Extermination is possible. It occurred in the geological past, before man evolved, and it occurs today. Perhaps the passenger pigeon foretells the fate of the chestnut, or perhaps that tree will some day make a successful response to the blight.

Natural selection may be, as McAtee (1949) insists, a purely negative principle. Nevertheless, the results of this force, when coupled with the struggle for existence, as Darwin closely united the two, may lead to positive results and the survival of a threatened and badly mauled species such as the chestnut or the fever tick.

The instances where natural barriers have broken down, and organisms have invaded new areas to the detriment of forms formerly successful in that area are too numerous to enumerate. We may observe today the effects of the invasion of the upper Great Lakes by the sea lamprey. The geological record shows the effects upon the native fauna of the invasion of South America by northern mammals at a late period. Indeed the geology of that continent influenced markedly the character of the *Origin of Species*. The generalizations Darwin formed from observations in that land and elsewhere might have enabled a keen analyst to predict the results of our modern uses of insecticides. It is very difficult to formulate terms or phrases which will describe these broad principles without in some degree giving offense to someone's semantic preconception. However, Darwin's terms such as, "struggle for existence," and "natural selection," suggest the relationships as they actually exist. Possible "survival of the fittest" should be discarded for reasons of an emotional nature, but the others may be used in a large and almost metaphorical sense as Darwin intended, at least until better terms are formulated.

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# THE MIXED-BLOOD RACIAL STRAIN OF CARMEL, OHIO, AND MAGOFFIN COUNTY, KENTUCKY

EDWARD T. PRICE
Department of Geology and Geography
University of Cincinnati, Cincinnati, Ohio

A number of population groups of dark-skinned peoples, recognized as socially distinct in rural localities of eastern United States, are commonly assumed to be tri-racial, mixed from white, Negro, and Indian ancestors. A small example of such a group is mentioned by *The Ohio Guide* (1) as living in the vicinity of Carmel in Highland County. Aside from another small mixed-blood settlement of very different circumstances in Darke County, this group near Carmel is probably the only one to be found rooted in Ohio.

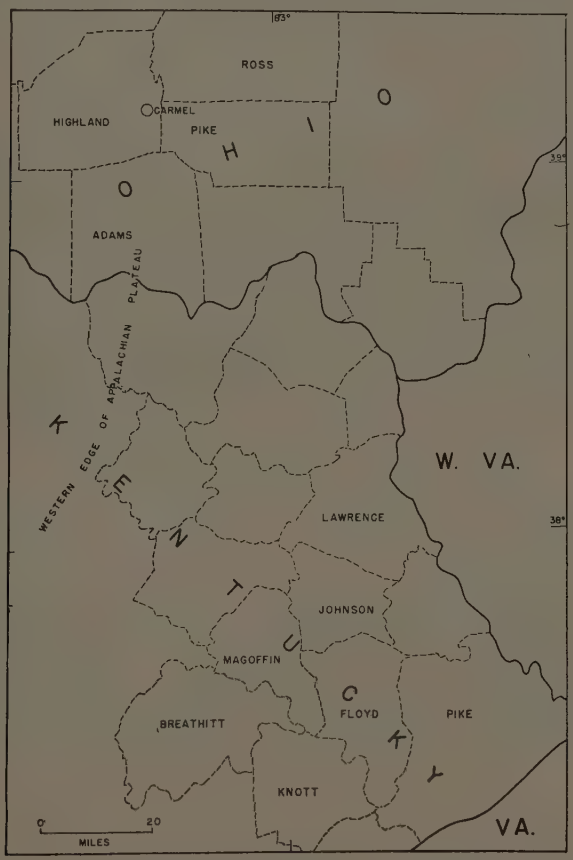


FIG. 1. Location map showing Carmel and Magoffin County.

## MIXED-BLOODS OF CARMEL

Carmel is a cross-roads hamlet based on a school, a church, and a country store. Its location on the margin of the Till Plains, half surrounded by the wooded hills which mark the western edge of the Appalachian Plateau, is probably significant for the phenomenon which brings it this notice (figs. 1 and 2).

The "half-breeds" or "Carmel Indians," as they are locally identified, are well known to the farmers of the vicinity, who, on the surface at least, accept good-naturedly the claim of the former to Indian ancestry. Privately the question of Negro blood also may be raised. Most of the older residents think that both are present and can name families or individuals who they think illustrated each type in the days before the mixing was so thorough. The group look mixed; a few of them are nearly white, but most are identifiable by their brown or tan skin; many of them have curly black hair, and many have straight black hair. Few, if any, really look like Indians, but identifying negroid features are not usual. I consider it likely that Indian and Negro mixtures are both present on the basis that the degree of pigmentation in most of the people otherwise seems inconsistent with their general lack of negroid features (figs. 3, 4, and 5).

FIG. 2. The Waverly cuesta, western edge of the Appalachian Plateau. Carmel lies at the foot of the hills on the left.

The surnames of the members of this group are, with few exceptions, Gibson (Gipson), Nichols, and Perkins. One or two other names have recently been added to the group by marriage. Some of the Gipsons aver that the Gibsons have a trace of Negro blood. In the summer of 1947 their number was determined to be at least 150; the population is said to have been somewhat larger in times past.

These half-breeds usually reside in the hilly part of the Carmel environs. Their homes are characteristically one-room shacks, a few of which are mud-chinked log cabins. Some live as tenants on farms of the vicinity; in recent years a few have been able to purchase small tracts of land. Traditionally they have been squatters, taking advantage of the unused hill land, tolerated by the owners as long as they seemed useful to the community as a source of farm labor. A group of shacks occupied in one of the hollows is known as "Pocahontas Row."

In addition to sporadic work on farms, the Carmelites have supported themselves in various ways, partly from the hill lands where they hunt squirrels and ground-hogs (in season or out) for food, dig ginseng (*Panax quinquefolium*) and yellowroot (*Hydrastis canadensis*) for sale to herb houses through the local stores, and obtain wood for fuel and building. Most of them keep chickens, which run in and out of the houses freely in summer, and some keep pigs. Many cultivate

small garden patches, and occasionally one may have the land for a corn crop. Petty theft, particularly of feed grains, has been attributed to them. One family, apparently not connected with the others, has made a business of weaving and

FIG. 3. Carmel family and house.

FIG. 4. Carmel family.

selling baskets. Various public welfare payments have contributed to their support in recent years, to the great irritation of their neighbors.

In cultural terms the Carmel Indians represent an intrusion of the Kentucky Mountains into the Middle West. The country people are quick to point out their

differences in language—the prevalence of non-grammatical phrases and the use of old forms such as "holp" and "poke;" "hit" is common for "it," and "lamp oil" is the phrase for kerosene. The laundry is boiled in the outdoor kettle, and the more industrious string their "shuck beans" on the porch to dry out and produce a supply of food for winter (fig. 6). In their numerous progeny and in their general family relations they also correspond closely to the rural Ohioan's concept of Kentuckians.

The Carmelites are considered extremely shiftless by their neighbors; it is the characteristic belief (perhaps worthy of study itself) that nothing can be done for them which will permanently raise their low standards. This impression of an ambitionless existence is supported by direct observation of some of the people.

FIG. 5. Carmel children of closely related families. The light and dark types stand in striking contrast.

The visitor is likely to find most of the residents of a house in a sitting or reclining position. One with whom I talked had planned a tobacco crop, but had only poor excuses for not having started it by mid-June. Malnutrition might well provide a physiological basis for the continuance of this inertia, which few incentives seem to overcome.

The cultural peculiarities are not needed for determining the source of the mixed breeds, for it is common knowledge in the community that Magoffin County, Kentucky, is their original home. Many of the present residents were born in Magoffin County, and they return there frequently for visits, some wintering in Kentucky regularly. Lack of economic opportunity was apparently the reason for their leaving Magoffin County, and, indeed, some of the Carmel people move on north for seasonal employment in the Scioto onion marshes or work on railroad gangs. Carmel, however, has the aspect of home to many of these people, and they are likely to come back again. On returning to Carmel, they may move into vacant shacks or, finding the old homes torn down, move in with neighbors. It is a standing joke in the community that one never knows how many people he may find living in one of the shacks.

The termination of their original northward movement at Carmel is probably a matter of chance, but, once arrived, they found an ecological niche which offered them the needed sources of support. The juxtaposition of reasonably good agricultural land and steep hill land replete with the hollows of an irregular boundary seems to have offered in one locality farms prosperous enough to provide employment and a refuge for residence locations; their shacks are sheltered from the winds of the open plains and from easy observation; they are off the arable land whose use the farmer would refuse, but accessible to building material, fuel, food, and a source of supplementary cash. The farmer in his turn gained a source of labor which would not only not demand high wages, but may not have even desired steady work.

FIG. 6. Shuck beans strung up to dry on porch in Tennessee. This practice is also reported at Carmel.

## MIXED-BLOODS OF MAGOFFIN COUNTY

Investigation of Magoffin County as the source of the Carmel people soon disclosed that it too, with adjacent sections of Floyd County, is the home of a mixed group. Magoffin is a typical Kentucky Mountain County with little to distinguish it from many others. The better farming land is in the narrow valleys, the poorer on the lower slopes of the hills. As in most of the mountain counties, Negroes are almost completely lacking.

The mixed-bloods are accepted without serious question as to origin or status. Many of them own farms, some of the hillside variety, others of somewhat better nature. In Magoffin County their ownership of submarginal land is traditional, whereas in Carmel it is new. They are usually considered to be part Indian, though a few people prefer to call it Negro, and they have been famous for their large families and their ability to keep them going without apparent means of support. Many have also been farm laborers. Their habits of ridge farming and of hunting with their numerous dogs are usually attributed to their Indian blood.

Most of the Magoffin County mixed-bloods who are recognizable today have straight black hair, rarely wavy. The suggestion of Indian blood is more easily

accepted than is the case with any other such group I have visited (figs. 7 and 8). Intermarriage with unmixed whites is not unusual at the present.

In view of the derivation of the Carmel group from Magoffin County, two curious differences between the two groups met my observation: The Magoffin mixed-bloods are generally lighter in skin color, and their residence in the area is more dispersed. There are, perhaps, 200 of the mixed-bloods in Magoffin County now; they are considered to be fewer in number and less Indian-like in appearance than in the earlier days recalled by old-timers. The surnames found among the

FIG. 7. Member of the Magoffin County group interrupted while interplanting the corn with beans. She claims to be three-fourths Cherokee and appears to be partially correct.

Carmel group are prominent and are said to belong exclusively to the mixed-bloods in Magoffin County; Cole, Hale, Harmon, and Barnett are also characteristic surnames.

Big Lick, Middle Creek, and Mason Creek (fig. 9) are mentioned as residence localities for the mixed-bloods, but the Big Lick, in reality a short narrow branch, is the only concentration of them. It contains six houses and some very poor sites for farms, but a map of 1915 showed 16 houses in addition to the school (2). A former teacher at the school said that it had 68 pupils in 1925, some of them grown, but none advanced beyond the third grade; the school's enrollment of 23 in 1947, over half of whom actually lived on the Big Lick, also indicated the population decrease. Within the last 40 years the people have been converted to the Holiness

sect, which has erected a church at the mouth of the stream. This area was dominated by the Cole family and is yet known as the "Cole Nation."

The conversation of the Magoffin County mixed-bloods confirms the conclusion that the different families in scattered parts of the country are closely related. Some of this group also migrate to the onion marshes and other places where seasonal employment may be obtained.

FIG. 8. The two girls are granddaughters of the woman in Fig. 7. The bark is from "Indian arwood," which the mother digs.

## HISTORY OF THE MIXED-BLOODS

Some members of both the Carmel and Magoffin County groups claim Cherokee Indian ancestry and refer to forebears who came from "Old Virginia" or Tennessee. The story of their origin told by white residents of Carmel involves settlement nearby of a slave-holding family from Virginia shortly before the Civil War. It asserts that the slaves, who were named Nichols, were freed by their move into Ohio, but continued to live in the community and married the later immigrants from Kentucky, who bore the names of Gibson and Perkins. On the other hand a county historian (3), who has long been interested in the backward peoples of the locality, thinks that Shawnee Indians surviving in the area formed the nucleus of the group and that they have only recently mixed with the immigrants from Magoffin County.

The census records (4) support neither of the last two accounts. The first trace of these mixed people at Carmel appears in the 1870 schedules and shows that all of them had ties with Magoffin County. Five families listed as mulatto in Brush Creek Township (Carmel) included three Gibsons, a Nichols, and a Perkins. Some of the older members of these families were born in Virginia and Tennessee. In 1880 the count of these families was: Nichols 10, Perkins 2, Gibson 1; all the family heads were born in Kentucky. As a matter of interest, the census of 1890 (5) recorded more Indians resident in Highland County than

in any other Ohio County; the number was 22, and all were in Brush Creek Township.

Very few marriages involving members of this group were recorded in the Highland County records before 1900; it is said that they seldom troubled to legalize their marriages until very recently. Between 1900 and 1946, 46 marriages recorded in Highland County involved persons from the Carmel group as identified by name (or name of parents) and residence or birth in Carmel or Magoffin County; both parties to 24 of these marriages were so identified. In other words, over two-thirds of the mixed-bloods whose marriages were so recorded and identified married other members of the group. This rate of in-marriage, indicated also by the paucity of surnames, is surprisingly high for a small group removed from its original home. At least a third of the parties to these marriages were unable to sign their names.

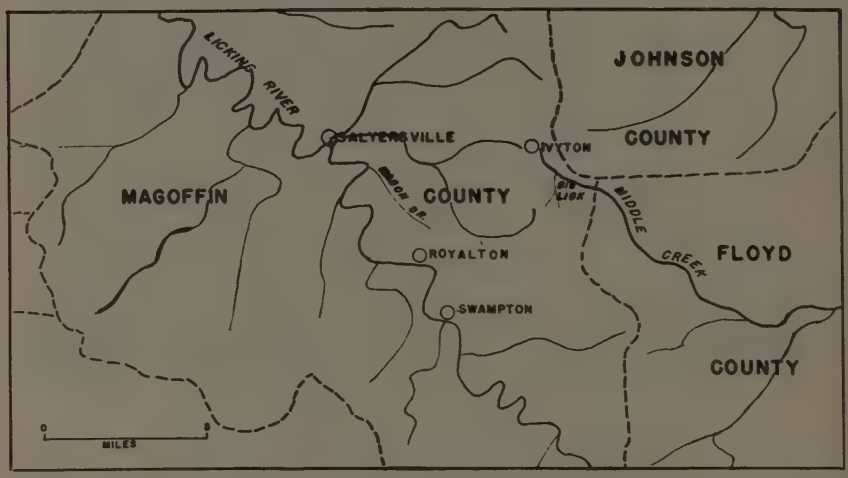


FIG. 9. Location map of Magoffin County area.

The census schedules indicate that some ancestors of this mixed group were in Floyd County (which then included Magoffin) by 1810. In the census of 1820 several of these families were listed as free colored persons. In 1850 and subsequent years members of the same group of people were variously listed as both white and mulatto. Their numbers increase with successive censuses. It is evident that this racial mixture is a matter of long standing with these people and that the first of their ancestors to settle in Kentucky were mixed themselves. Virginia, Tennessee, and North Carolina appear in the census schedules as states of birth of the early settlers.

The racial distinctions indicated by the censuses may have played a part in the selection of emigrants from Magoffin County. The darker-skinned members of the group may have found fewer opportunities at home and may have played a disproportionate part in the movement. Another possible explanation of the darker complexion found among the people at Carmel is the greater opportunity available there for marriage with Negroes.

It is a matter of considerable interest that the records indicate with reasonable probability a connection between the Magoffin County mixed-bloods and the better known and more numerous Melungeons of eastern Tennessee and southwest

Virginia. This case rests on the identification of mixed-bloods in the records by two conservative properties: their surnames and their classification as free persons of color or mulattoes; this method is considered valid because of the facts that the census records list few free persons of color aside from those bearing the names of present interest, and that these names are usually grouped when they do appear.

TABLE I

NAMES OF MELUNGEONS AND MAGOFFIN COUNTY MIXED-BLOODS

| Recognized Melungeon Names Today | | Recognized Names of Magoffin County Group |
|---|---|---|
| Collins | Williams | Gibson |
| Gibson | Barnett (?) | Perkins |
| Goins | Freeman | Nichols |
| Mullins | Sexton | Cole |
| Moore | Bolen | Collins (?) |
| Minor | Bell | Hale |
| Delph | Mize | Harmon |
| | | Barnett |

TABLE II

SELECTED CENSUS DATA ON FREE COLORED FAMILIES BEARING NAMES COMMON AMONG THE MELUNGEONS AND MAGOFFIN COUNTY MIXED-BLOODS

| County | State | Name | Number of Families | Year State of Origin (if not Ky.; given only after 1840) |
|---|---|---|---|---|
| Known Melungeon localities: | | | | |
| Wilkes | N. C. | Nichols | 1 | 1790 |
| Hawkins | Tenn. | Hale | 2 | 1830 |
| | | Cole | 1 | 1830 |
| | | Moseley | 2 | 1830 |
| Claiborne | Tenn. | Cole | 1 | 1830 |
| Cocke | Tenn. | Nichols | 5 | 1840 |
| Letcher | Ky. | Nicholas | 1 | 1850 Tenn. |
| | | Perkins | 1 | 1860 Tenn. |
| Possible Melungeon locality | | | | |
| Campbell | Tenn. | Perkins | 1 | 1830 |
| Counties between Melungeon and Magoffin areas | | | | |
| Pike | Ky. | Moseley | 1 | 1830 |
| | | Gipson | 2 | 1830 |
| | | Collins | 1 | 1860 |
| Harlan | Ky. | Cole | 1 (Indian) | 1860 Va. |
| Knox | Ky. | Harmon | 1 | 1860 |
| | | Goins | 1 | 1860 |
| | | Goings | 1 | 1860 |
| Magoffin-Floyd area | | | | |
| Floyd | Ky. | Moore | 2 | 1850 N. C. |
| | | Mosley | 1 | 1850 Tenn. |
| | | Moore | 8 | 1870N.C.,Ky.,Va. |
| | | Mosley | 1 | |

(In 1947 both Floyd and Knott Counties, Ky., had people named Moseley who are considered to have Indian blood.)

The significant name data from the census records are summarized in Tables I and II.

Gibson is now the only important name shared by Melungeons and Carmel-Magoffin mixed-bloods. All other common surnames of Magoffin County people may be identified among free colored people who the census schedules indicate have lived in association with Melungeons. Free colored persons bearing two Melungeon names (Collins, Moore) have lived in association with the ancestors of the Magoffin County people, and the name of another eastern Kentucky family (Moseley) now rumored to possess Indian blood is associated in the records with both the Melungeons and the Magoffin County people. The counties containing these people form a chain which is continuous between Magoffin County and the Melungeon home area which centers in Hancock County (formerly included in Hawkins), Tennessee. The names of a few individuals in census and county records also lend weight to these conclusions.

## CONCLUSIONS

These mixed-blood groups then appear as by-products of two larger population movements, one westward, the other northward. Mixed-blood peoples from the Southern Seaboard states moved westward with the stream, concentrating in certain localities. The Magoffin County group was formed by branches of this stream from the east as well as northward-moving offshoots of the Melungeons. The original populations were very small, but they increased by natural reproduction; the mixed-bloods were distinguishable from other mountain residents only by their names, color, and reputation. Beginning about the time of the Civil War, Magoffin County served in turn as the jumping-off place for a move across the Ohio. The latter move brought to Carmel a mixed-blood population entrained by the general emigration from overcrowded parts of Kentucky.

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(4) Original schedules of undestroyed U. S. censuses up to and including that of 1870 are filed by year, state, and county in the U. S. National Archives, Washington, D. C. The 1880 census is available on microfilm at the D.A.R. library, Washington.
(5) Eleventh Census of the United States. Report on Indians Taxed and Indians Not Taxed in the United States. Washington, U. S. Government Printing Office, 1894, p. 527.

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## FIFTIETH ANNIVERSARY

OF

## THE OHIO JOURNAL OF SCIENCE

In November, 1900, the first issue of the Ohio Naturalist was published. The Ohio Naturalist later became the Ohio Journal of Science. The publication of this issue marks a half century of service to science.

# NEW SPECIES OF ERYTHRONEURA OF THE MACULATA GROUP

## (Homoptera: Cicadellidae)

HERBERT H. ROSS
Illinois Natural History Survey, Urbana, Illinois
AND
DWIGHT M. DeLONG
Ohio State University, Columbus, Ohio

The species described below all occur in Illinois, with additional records for some from the Great Smoky Mountains region. In working out the identity of these species there arose a need for clarification of the definition of the Maculata Group.

In current and past North American literature, the genus *Erythroneura* has been divided into a series of groups on the basis of wing venation. There has been considerable difference of opinion among various authors as to the number and limits of these groups, due in part to the variability of the venational characters, even within the same species, and in part to the admitted arbitrary nature of the groupings. A much sounder basis for subdividing the genus using characters of the male genitalia has been advocated by Ribaut and other European authors. These are summarized by Ribaut 1936 (Faune de France, 31, Typhlocybidae).

A survey of genitalic types of the Maculata Group shows that two major groupings are represented. One contains only the species *illinoiensis* (Gillette), with its two color forms *regalis* Beamer and *spectra* McAtee. This species can be placed satisfactorily in Ribaut's Fasciaticollis Group, characterized by the evenly convex foot of the style and the short, simple pygofer hook. The second group includes all the other species placed in the Maculata Group by DeLong and Knull 1945 and Oman 1949 in their check lists of the North American forms; it apparently is not represented in the European fauna, at least as reported by Ribaut. The Maculata Group may be characterized briefly as follows: style with a posterior point or a concave apical margin; pygofer hook straight or elongate, never short and hooklike, simple in most species but cleft to base in some, in which case the base is a single stalk, fig. 1; closely associated with the base of the pygofer hook is a sclerotized but undarkened, short rod which usually has the appearance of a basal spur, figs. 1–10. This is the largest known group in the genus, containing about 130 known species.

### **Erythroneura millsi** n. sp.

This species is closely related to *unica* Beamer, differing in the deeper cleft and long upper arm of the pygofer hook, and the shallower phalicata.

*Male.*—Length 2.9 mm. Ground color whitish cream; head with yellowish open diamond-shaped mark, pronotum with yellowish U-shaped mark; elytra with large pale orange anchor mark and apical spot on clavus, irregular orange marks making a zig-zag down corium, a pink border along the apical crossveins and associated veins, and a black spot in base of cell $M_4$.

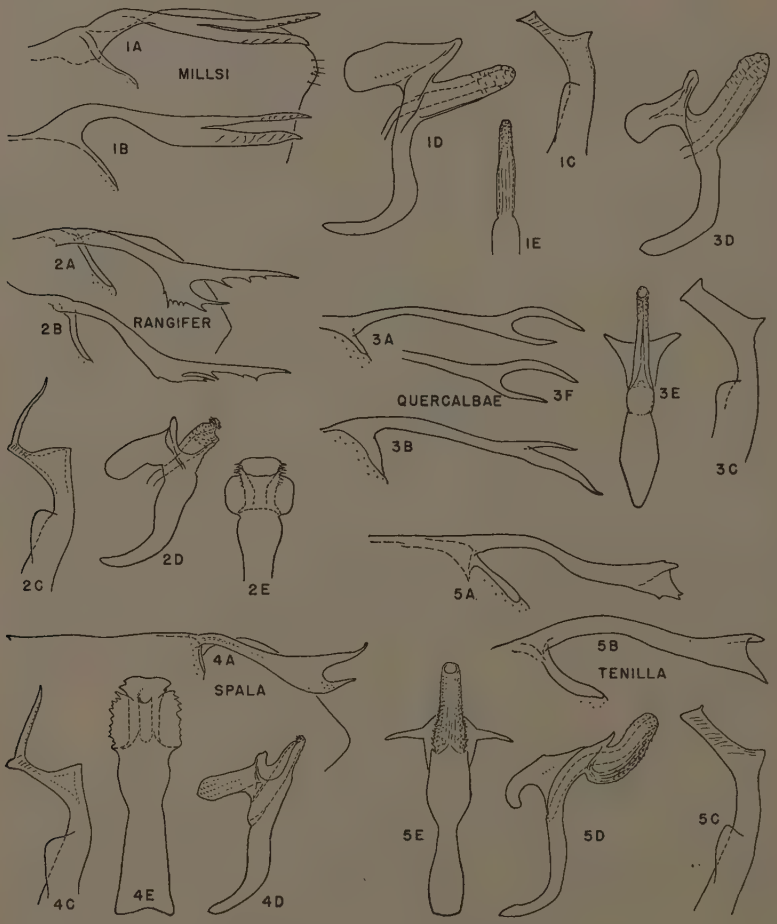
Genitalia as in fig. 1. Pygofer hook cleft slightly more than halfway to base, the two arms subequal in length, the dorsal one slightly stouter; the base is narrow, curved, and turned, and expands into a broader portion before the base of the cleft, this condition being especially apparent from dorsal view, fig. 1*B*. Style with foot oblique to base, with sharp, projecting heel, sharp anterior point, and with the posterior point represented by only a sharp angulation. Aedeagus with phalicata situated just above the midline; phalicata with lateral aspect long, moderately deep, nearly parallel-sided, and rounded at apex, and with posterio-ventral aspect narrow, parallel-sided, and with a very narrow lateral flange from base to well beyond the midpoint.

Holotype, male, Gibsonia, Ill., July 14, 1948, on *Quercus stellata*, Mills and Ross (INHS).

This specimen was taken in company with several similarly marked females from an isolated tree, and may represent a host association.

**Erythroneura rangifer** n. sp.

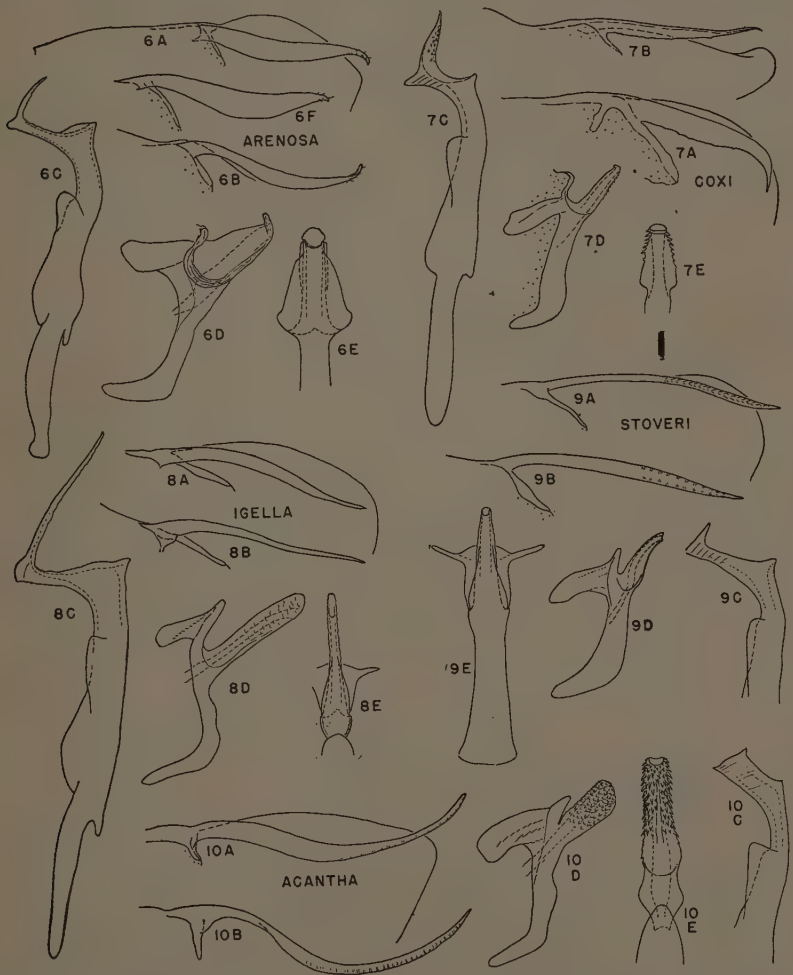
The curious pygofer hook of this species is unlike that of any other known species. The short, wide phalicata indicates a close relationship with *aesculi* Beamer and *spala* n. sp., but in these two the pygofer hook is different.




## ILLUSTRATIONS

In the plates accompanying this article, all the figures of a species are magnified to the same scale except for some of the aedeagus, which are 1.5 times the others. Those at a higher magnification are figs. 1*D*, 1*E*, 2*D*, 2*E*, 4*E*, 6*D*, 6*E*, 9*E*, and 10*E*. The view of the aedeagus shown in all *E* drawings is roughly posterio-ventral, and is the aspect at right angles to the long axis of the phalicata alone.

*Male.*—Length 2.8 mm. Ground color pale straw color; markings on head and pronotum indistinct; elytra with markings similar to preceding species but those which are orange and pink in that species are pale yellow in this. Genitalia as in fig. 2. Pygofer hook elongate, surpassing apex of pygofer, the base slender and curved, the apex cleft to form a long, slender dorsal arm and a shorter, curved ventral arm, both serrate with a few sharp, projections; the dorsal aspect is markedly sinuate, and the entire apical portion is thin and foliaceous. Style with foot of moderate size, heel large and triangular, anterior point inconspicuous, and posterior point slender, slightly




FIGS. 1–10. Male genitalia of *Erythroneura*. *A*, pygofer hook, lateral aspect; *B*, same, dorsal aspect; *C*, style, drawn at right angles to large expanse of foot; *D*, aedeagus, lateral aspect; *E*, aedeagus or phalicata, posterio-ventral aspect, in figs. 3*E*, 5*E*, 8*E*, and 9*E* showing also the lateral expansion of the socket protruding from behind the phalicata; *F*, pygofer hook, dorso-lateral aspect.

sinuate, and longer than the length of the foot. Aedeagus with phalicata situated near dorsal margin; phalicata very short, fairly deep, and very wide, with sharp lateral projections on the main portion toward apex, bearing laterally a wide, smooth-edged flange extending almost the entire length of the phalicata.

Holotype, male, Rocky Branch, Clark Co., Ill., Sept. 14, 1949, on *Corylus americana*, Stannard and Ross, (INHS).

**Erythroneura quercalbae** n. sp.

This is a close relative of *mira* Beamer, differing from it in the U-shaped cleft of the pygofer hook and the forceps-like position of the two arms.

*Male.*—Length 3 mm. Ground color whitish cream; markings on head and pronotum indistinct; elytra with several pale yellow marks in basal portion, beyond this with a few thin, diagonal reddish marks and with a reddish border along the apical crossveins, and with a black mark in the base of cell $M_4$. Genitalia as in fig. 3. Pygofer hook with both lateral and dorsal aspects slightly curved, the apical third cleft to form two arms which curve toward each other at apex, the dorsal arm the longer, both arms and the basal portion of the hook slender. Style with foot oblique, the heel small and sharp, the anterior point minute but angulate, and the posterior point represented by a short, sharp, angulation. Aedeagus with phalicata situated just above the middle; phalicata long and fairly deep, the apex almost angulate, the ventral aspect narrow and parallel-sided, the apical portion with sparse imbrications.

*Female.*—Similar in size, shape, and color to male.

Holotype male, Elkmont, Tenn., Gt. Smoky Mts. National Park, Sept. 1, 1948, on *Quercus alba*, Ross and Stannard, (INHS). Allotype female, same data. Paratypes, same data, 15♂, 12♀. Kickapoo State Park, Ill., July 28, 1948, on *Quercus alba*, Sanderson and Becker (INHS). Paratypes in INHS and collection of D. M. DeLong.

**Erythroneura spala** n. sp.

This species is closely related to *bifida* Beamer, from which it differs in the swollen and upcurved lateral aspect of the pygofer hook.

*Male.*—Length 2.8 mm. Ground color whitish; head and pronotum with only indistinct markings; elytra with black spot in base of cell $M_4$ and with indistinct yellow markings shaped and situated as in *millsi*. Genitalia as in fig. 4. Pygofer hook thin and foliaceous, the lateral aspect curved first down then up, the base slender, the middle portion gracefully expanded, the apex cleft to form a pair of tapering, sharp-tipped arms separated at base by a U-shaped outline. Style slightly oblique, the heel fairly large and angular, the anterior point small and rounded, and the posterior point slender, almost straight, and longer than the foot. Aedeagus with phalicata situated very close to its dorsal point; phalicata short, shallow, but wide and bearing a wide flange with serrate edges.

Holotype, male, Rocky Branch, Clark Co., Ill., Sept. 14, 1949, on *Fagus grandifolia*, Stannard and Ross (INHS). Paratypes, Rocky Branch Cr., Oliver, Ill., April 22, 1949, Stannard and Ross, 1♂ (INHS); Marshall, Ill., April 22, 1949, Stannard and Ross (INHS and coll. D. M. DeLong).

**Erythroneura tenilla** n. sp.

In general characteristics this species approaches *manus* Beamer, but differs in the shape of the aedeagus and the less sinuate pygofer hook.

*Male.* Length 2.9 mm. Ground color whitish; elytra with black spot in base of cell $M_4$, reddish border along apical crossveins, and orange spots as follows: an anchor mark and apical mark on clavus, and three sinuate marks on corium. Genitalia as in fig. 5. Pygofer hook with lateral aspect sinuate, dorsal aspect slightly so, fairly robust, gradually expanded toward apex, the latter incised to form dorsal and ventral angles which are slightly serrate with a few sharp, small points. Style with foot oblique, heel sharp but not large, anterior point blunt, posterior point minute but finger-like. Aedeagus with phalicata situated at dorsal point, the socket profile sinuate and the phalicata curving slightly down from it, then up; phalicata fairly deep, its apex rounded, its ventral aspect wide at base and tapering to a fairly narrow apex, its apex and sides with numerous spiculations.

Holotype, male, Elkmont, Tenn., Gt. Smoky Mts. National Park, Sept. 1, 1948, on *Quercus alba*, Ross and Stannard (INHS). Allotype, female, same data. Paratypes, Marshall, Ill., April 22, 1949, in woods, Ross and Stannard, 2 ♀ (INHS and coll. D. M. DeLong).

**Erythroneura arenosa** n. sp.

This species is a close relative of *marra* Beamer, differing in the wide pygofer hook, unexpanded apex of phalicata, and small heel.

*Male.*—Length 2.8 mm. Ground color whitish; pattern similar to the preceding species but with the markings pale yellow except for the black spot in cell $M_4$. Genitalia as in fig. 6. Pygofer hook foliaceous and moderately long, extending to tip of pygofer, slightly sinuate, in lateral view curving ventrad at extreme tip; it is seen at its widest from dorso-lateral view, fig. 6*F*, when it appears markedly fusiform. Style with foot slightly oblique, heel sharp, ball of heel with a convex flange, instep narrow, anterior point short and round, posterior point slender, sharp, curved slightly toward heel, and a little longer than half length of foot. Aedeagus with phalicata angling only slightly from socket, and its dorsal margin almost contiguous with the dorsal point of the socket; phalicata deep, narrowing toward apex, apex upturned to form a small flange; ventral aspect of phalicata with main body narrow and parallel-sided, each side with a lateral flange which is wide at base and tapers into the body just before apex.

Holotype, male, Thornton, Ill., Sept. 7, 1949, on *Corylus americana*, Ross and Stannard (INHS).

**Erythroneura coxi** n. sp.

Although key characters indicate a proximity of this species to *continua* Knull and Auten, it does not seem closely related to any known species. From *continua* it may be separated by the bladelike pygofer hook and less angular posterior point.

*Male.*—Length 2.7 mm. Ground color white, with irregular pinkish spots on head, thorax, and elytra; these are remarkably similar to the arrangement found in *maculata* (Gillette). Genitalia as in fig. 7. Pygofer hook thin and bladelike, angling slightly ventrad, its apex curved sharply ventrad and ending just within the outline of the pygofer; lower margin with small, well spaced serrations; basal rod unusually large. Style with foot almost at a right angle with long axis of style; heel small and sharp, anterior point blunt but fairly long, posterior point wide at base, tapering to sharp apex, slightly sinuate, inner margin concave, and as long as foot. Aedeagus with phalicata fairly close to dorsal point and angles only slightly from socket; phalicata shallow, straight, the tip with a slight dorsal point, the ventral aspect fairly narrow with a wide flange down each side, serrate on apical half.

*Female.*—Size, shape, and color as for male.

Holotype, male, North East, Pa., Oct. 14, 1949, on purple raspberry (*Rubus* sp.), J. A. Cox (coll. D. M. DeLong). Allotype, female, same data. Paratypes, same data, 66 ♂, ♀; same data but Sept. 26, 14 ♀, ♀ (coll. D. M. DeLong and INHS). This seems to be the first definite host record of an *Erythroneura* from *Rubus*.

**Erythroneura igella** n. sp.

The large foot and extremely long posterior point of the style place this species at once in the *mirifica-penesica-parva* complex. From these it differs in the longer pygofer hook and the shallower phalicata.

*Male.*—Length 2.8 mm. Ground color whitish; black spot in base of cell $M_4$, otherwise markings very pale and indistinct. Genitalia as in fig. 8. Pygofer hook curved downward, slightly sinuate, not quite attaining edge of pygofer, of moderate width at base and tapering gradually to a thin apex. Style with large foot set at about a right angle with axis of style; heel small and sharp, anterior point scarcely differentiated, posterior point slender, nearly straight, and exceedingly long, at least one and a half times length of foot. Aedeagus with phalicata set at a sharp angle with socket and situated just above midpoint; phalicata long, shallow, and parallel-sided, its ventral aspect narrow, slightly widened at base and with a small flange at each side on basal half, the apical half of the structure with a few scattered imbrications.

Holotype, male, Belle Smith Springs, Ill., July 16, 1948, on oak, Mills and Ross (INHS). Golconda, Ill., July 23, 1947, on *Quercus imbricaria*, Sanderson and Stannard (INHS).

**Erythroneura stoveri** n. sp.

The short posterior point of the foot and the elongate, nearly straight pygofer hook place this species in the vicinity of *campora* Robinson, but *stoveri* may be readily distinguished from this and related species by the curious beaklike phalicata.

*Male.*—Length 2.7 mm. Ground color white; head with thin, pink diamond mark, pronotum with lateral spots and mesal U-spot pinkish; elytra with black spot in base of cell $M_4$, and pinkish marks as follows: clavus with a middle square mark and an apical mark, corium with scattered marks forming an indefinite and disconnected zigzag, and a border around the apical crossveins. Genitalia as in fig. 9. Pygofer hook elongate, extending slightly beyond pygofer, lateral aspect slightly sinuate, slender, of nearly equal thickness throughout, and pointed at apex, dorsal aspect slightly fusiform and tapering more suddenly toward apex. Style with slightly oblique foot; heel small and projecting, anterior point only a blunt angulation, posterior point sharp, only slightly longer than depth of instep, instep long and slightly but gently concave. Aedeagus with phalicata set near dorsal point, curving out only slightly from socket; phalicata sinuate, widest at base and tapering to a spoutlike apex, with narrow lateral flanges on basal half and very minute serrations toward apex.

Holotype, male, Rocky Branch Cr., Oliver, Ill., April 22, 1949, Ross and Stannard (INHS). Paratypes, same data, 5♂ (INHS and coll. D. M. DeLong).

**Erythroneura acantha** n. sp.

This species is most closely related to *lenta* Beamer, differing in the tapering pygofer hook and shape of phalicata.

*Male.*—Length 2.9 mm. Ground color white; markings on head and pronotum indistinct, on elytra of usual type but pale yellow and also indistinct. Genitalia as in fig. 10. Pygofer hook very long, extending beyond pygofer; lateral aspect slightly sinuate and curving dorsad at apex, the basal portion fairly deep, the apical half slender; dorsal aspect very sinuate and appearing to have a slender base. Style with foot oblique; heel, anterior point, and posterior point each represented by a small, sharp angulation; foot in general short and deep, with a nearly straight instep. Aedeagus with phalicata situated near dorsal point, and angling markedly from socket; phalicata of moderate length, lateral aspect slightly clavate, ventral aspect stout and parallel-sided except for a slight enlargement at base, almost the entire phalicata beset with sharp spines.

Holotype, male, Fairfield, Ill., July 14, 1948, on *Carya ovata*, Mills and Ross (INHS). Paratypes, Rocky Branch Cr., Oliver, Ill., April 22, 1949, Ross and Stannard, ♂ (INHS); Edgerwood, Ill., July 23, 1947, on *Quercus imbricaria*, Sanderson and Stannard (coll. D. M. DeLong).

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# MINERAL RESOURCES RESEARCH AT THE ENGINEERING EXPERIMENT STATION OF THE OHIO STATE UNIVERSITY

CHARLES H. BOWEN
Research Engineer, Mineral Resources
Engineering Experiment Station, The Ohio State University
Columbus, Ohio

The Engineering Experiment Station of The Ohio State University was established by legislative act in 1913. It is affiliated with the College of Engineering and operated as a part of that division of the University. As stated in the law, "The duties of the Engineering Experiment Station shall be to make technical investigations and to supply engineering data which will tend to increase the efficiency and safety of the manufacturing, mineral, transportation and other engineering and industrial enterprises of the state and to promote the conservation and utilization of its resources." Any of the state agencies may seek assistance from the Station; the expense of the research being borne in full or in part by the petitioning agency, according to the judgment of the Engineering Experiment Station Advisory Council. Citizens of Ohio, business enterprises, etc., may also seek such assistance, subject to certain specifications and contractural agreements.

Studies of Ohio's mineral resources are a very important function of the Engineering Experiment Station. Because of the importance of this work and the need for better integration of effort, a special project was established in 1946. One of the duties of the supervisor of this project is to act as liaison between the Engineering Experiment Station, industry and other state and federal agencies. As a result of many technical investigations of Ohio's mineral resources certain facts and trends have been revealed that may be of interest and assistance to the geologists of the state. These will be considered under each of the major lines of interest of the Engineering Experiment Station.

## FUELS RESEARCH

As a result of increased general interest in synthetic fuels many low-temperature carbonization tests of coals and shales have been made in recent years. It has been found that the oil yield from Ohio coals, by this method, compares favorably with yields from coals of other states. In 1948, the Geological Survey of Ohio sampled several coals and carbonaceous shales. These samples were analyzed at the Engineering Experiment Station and a bulletin summarizing the data is in preparation.[1]

Another phase of the synthetic fuel study has been to investigate the Ohio shale as a source of oil. Analyses of sample suites taken through the entire thickness of the formation show a general three-fold division of the unit in southern Ohio. The upper 80 to 90 feet are the richest, yielding from about 5 to 14 gallons of oil per ton. The middle portion gives the lowest assays, 0 to 4 gallons per ton and the lowermost portion gives somewhat intermediate oil yields. These facts are consistent with the three-fold division of the Ohio shale noted in the northern part of the state.

From analyses to date it may be stated that the Ohio shale is not suitable for oil production *under present economic conditions*. Should the economic factors undergo a distinct change, or should sufficiently valuable by-product uses be discovered, certain areas of this large deposit of low-grade material may be amenable to exploitation. The survey of this resource is not complete but sufficient data

[1]Bowen, C. H., Smith, W. H., and Krumin, P. O. "Further Studies of Ohio Coals and Shales," Ohio State University Engineering Experiment Station, *Bull. 148*.

are available to indicate that further investigation can be made somewhat incidental to other research problems.

*Coal Beneficiation*

Other fuels research includes a coal beneficiation project whose aim is to improve the quality of Ohio coals for the general fuel market and for use in the production of synthetic fuels. This coal beneficiation project is being done in cooperation with the Division of Geological Survey. The Meigs Creek, or number 9 seam, is the coal being investigated at present, inasmuch as it constitutes the largest undeveloped reserve of coal in Ohio. The research will attempt to determine the nature and mode of occurrence of the sulphur and ash, and to determine what processing will be required to economically remove those impurities.

The beneficiation program may have more far reaching results than those expressed in our immediate aims. No Ohio coal is used by the coking industry at present, but when the low sulphur coking coals of the Appalachian Field are exhausted certain of Ohio's coals may be beneficiated to the extent that they too will be used in this industry. Demorest[1] found that the numbers 6, 7 and 8 seams would coke, especially if cleaned and then blended with low-volatile coal.

*Underground Gasification*

A rather new development in the utilization of solid fuels is the underground gasification of coal. In this process the fuel values are extracted as a gas without recourse to customary mining techniques. The coal seam is set on fire and the gases extracted by means of drill holes and/or simple mine entries. Since the strata overlying the coal form the retort, the character and thickness of these strata are of prime importance. According to the rather incomplete data available at present, the following generalizations may be made:

1. The cover should be quite thick in order that it may absorb any subsidence.
2. A thick shale series seems desirable; first, because through-going joints are not so common, and secondly, because in subsiding the broken shale rapidly increases in volume, filling the void and hence does not tend to break to the surface.
3. Bloating and swelling of the roof rock under the action of heat is desirable; such bloating tendencies are often present in carbonaceous, pyritic and micaceous shales. The expansion of the roof rock tends to fill the burned-out area and crowd the air blast against the fire face. Limestone is undesirable as a roof rock because the carbonate decomposes, creating a still larger void and the carbon dioxide given off dilutes the effluent gases.

## CERAMICS RESEARCH

A great deal of the research at the Station has been in the field of ceramics. In structural clay products, for instance, the aim has been to find, test and develop standards for better raw materials; another aim is to develop better blending methods so that these raw materials will produce a ware having high strength, a long firing range and low porosity. It has been found that many of Ohio's shale units are admirably suited for such wares. In fact, a request was recently received from a North Carolina ceramic producer for sources of such Ohio shales so that he could purchase several carloads a week for blending with local material.

Several of the shales in the Coal Measurers are found to possess very desirable qualities. Of these the Clarion shale, of Hocking and Perry counties, is an outstanding example. Two Conemaugh shales, the Buffalo and Brush Creek, have been found suitable at least in places. The Mississippian Bedford shale is also widely used for brick and tile, and some of the shales of the Cuyahoga formation are utilized locally.

[1]Demorest, D. J. "Carbonization of Ohio Coals," Ohio State University Engineering Experiment Station, *Bull. 46*, 1928.

A shale showing the following properties will generally warrant testing for structural clay products:

1. A moderate amount of free silica.
2. Low carbon content.
3. Fairly high iron content, but disseminated and in the oxide form. Pyrite is deleterious.
4. Soft and friable, which is a fair indication of good workability.
5. No marked efflorescence at the outcrop which indicates the presence of harmful sulphur, sulphates and other soluble salts.
6. Presence of small quantities of finely divided (sericitic) mica.
7. Low lime and/or magnesium content, these constituents tend to shorten the firing range and to act as a bleach.

*Lightweight Aggregates*

Several Ohio materials are suitable for the manufacture of lightweight aggregates. Among the units tested and found good are the Ohio shale, Minford Silts, Bedford shale and several of the coal formation shales. Lightweight aggregate is essentially an artificial, vesicular lava. The raw material is heated rapidly so that the mass is viscous (pyroplastic) at the time that certain minerals decompose with the evolution of gas. The gas bubbles are entrapped in the somewhat viscous mass which is cooled before the gas completely escapes. Not much gas is required and, at present, it is believed that carbon and pyrite are the chief gas sources. Finely divided mica, in moderate quantities aids in fluxing and the water inherent in the mica molecule may aid in the blowing action.

*Other Ceramic Research*

The Minford Silt has been found to be a good glazing material if blended with some fluxing agent; by itself it is too refractory.

A profitable line of future investigation would be the beneficiation of some of our more plastic clays by the flotation process. There is a distinct possibility that clays such as the Clarion of Vinton County and the Lawrence of Lawrence County could be made into good substitutes for ball clays in the manufacture of whiteware.

## FOUNDRY SAND

The Experiment Station and the Ohio Division of Geological Survey are sponsoring an investigation of Ohio foundry sands; although the project is far from complete, certain facts and trends are now known.

So-called synthetic sand and clay mixtures are replacing naturally bonded molding sands, especially in the large foundries. This trend will work to the disadvantage of certain naturally bonded sand producing areas in the state, such as Gallia, Muskingum, Erie and Ashtabula counties. This need not be a total loss inasmuch as Ohio is rather well supplied with sources of clay-free base sands. The Sharon, Massillon and Black Hand sandstones are important producers of synthetic sands and are capable of even greater production. The Berea sandstone and the dune sands of the old lake beaches can also be treated (washed) to satisfy demands for which present producing units cannot qualify.

A second trend in foundry practice may also aid our synthetic sand producers. In the past the foundries wanted well-sorted sands, those in which the bulk of the sand was retained on three adjacent sieves, hence sands such as those from the St. Peter formation and from the dunes in Michigan commanded a premium market. Present foundry practice requires less well-sorted sands in which the bulk of the material is retained on 5 or 7 adjacent sieves. Under these specifications the well-sorted sands will loose their premium rating in the industry and Ohio's sands may be more favorably received by the foundry industry.

Present research is directed at other traditional foundry specifications, some of which work to Ohio's disadvantage. The trends seem to indicate that *some* of these specifications are merely traditions and have little basis in scientific fact. If and when these traditions are exploded (and it will be a difficult task) Ohio sand producers may be in a better competitive position than they now are.

### LIMESTONE

In 1948, the Engineering Experiment Station and the Division of Geological Survey co-operated in drilling a core hole through the Maxville limestone in Muskingum County. This hole was part of a program to explore sources of high-calcium limestone in Southern Ohio. The hole bottomed in the Vinton shales at 385 feet and showed about 70 feet of Maxville overlying them. The analyses indicate the existence of about 26 feet of rather good limestone and nearly the entire thickness is suitable for cement manufacture. The basal 8 feet of the Maxville shown in the core is a brecciated dolomitic limestone which, with the other lithologic and paleontologic variations noted could form the basis of an interesting geological study. As might be surmised from the thickness of the Maxville, the overlying Pottsville section was very short.

Other investigations in limestone and dolomite include the plotting of all existing quarries and collecting data on the physical and chemical properties of the rock. These data may be of some assistance in the correlation of strata and may also assist in noting areal variations in the units involved.

This paper has been a summary of *some* of the data available, at present. The incomplete results of some projects, and the contractural nature of others has precluded the making of any further statements at this time. However, the Station by means of its various publications, will make these results available as soon as possible.


## THE OHIO ACADEMY OF SCIENCE

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### MEMBERSHIP

Membership in the Academy is open to those interested in the advancement of Science, especially in the state of Ohio.

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The secretary will be pleased to supply membership information and application blanks upon request.

# THE OHIO JUNIOR ACADEMY OF SCIENCE

FREDERICK H. KRECKER

Department of Zoology, Ohio University,
Athens, Ohio

As every one connected with the Ohio Academy of Science knows, its officers and Council have been placing special emphasis upon making the Academy an organization which will serve all the scientific interests of the state. With this end in view, one of the projects recently undertaken by the Academy has been the organization of a Junior Academy of Science. Since most members of the Academy are probably not familiar with the scope of the Junior Academy's activities an outline of what it is intended to accomplish may be of interest.

Those who have been responsible for developing the Junior Academy have proceeded on the principle that the chief purpose in establishing such an organization is to aid in discovering and rewarding scientific ability among high school students. It has also been assumed that discovery and initial stimulation of talent among these students is in the hands of high school science teachers; that reward and encouragement toward continued effort is the function of the Ohio Academy of Science.

Past experience in the form of an earlier attempt to develop a Junior Academy revealed that an elaborate organization involving clubs, student officers, a student council, and all the other machinery made use of by their elders is more of a distraction to the students and a burden to their instructors than a help. Consequently, the present plans do not call for any organization among the high school students themselves. Their role is solely that of students interested in science who develop projects under the guidance of their instructors. In line with this, our plan calls for the students to be made junior members of the Ohio Academy of Science, and for the various activities of the junior members of the Academy to be directed by a Junior Academy Council, made up of college and high school science instructors. If conditions in individual instances favor some form of local organization, such as a science club, it may be established or advantage may be taken of an existing club but such action is a purely local measure. The Junior Academy as such takes no part in it.

High school science instructors and others whose primary interest lies in the development of science at the secondary school level, instead of belonging to a Junior Academy of Science, become members of the Ohio Academy of Science. A separate section, the Science Education Section, has been organized especially for this group of members, although they can belong instead to another section of the Academy if they care to. The purpose of the Science Education section is two-fold. In the first place, it serves as a means of bridging the gap between science teachers on the high school level and those on the college level. It also affords an opportunity for high school teachers of science throughout the state to exchange their views. Groups of teachers are usually organized on a strictly regional basis and so provide opportunity for an exchange of views on a regional basis only. There is ordinarily no opportunity for an exchange of views on a statewide basis. This opportunity the Ohio Academy of Science hopes to provide.

From all of this it can be seen that there is, in reality, no Junior Academy in the usual sense of the word. Instead, what we actually have is a Junior Division of the Ohio Academy of Science for high school students and a Science Education Section of the Academy for high school teachers. By these two devices the Ohio Academy is taking one more step toward welding the science minded persons of the state into a single unit, one that can truly be considered an Ohio Academy of Science.

The operation of the Junior Academy plan is as follows: The state has been divided into six districts, each centering about a college or university. Five of the regions have as a center one of the five state universities. The sixth region has Muskingum College as its center. Each year high school students interested in science who have developed some special project of a scientific character, exhibit the results of their efforts at the central institution in their district on what is termed a Science Day. This day is usually set sometime in April. It is supposed to come not later than two weeks before the annual meeting of the Ohio Academy of Science. Arrangements for the district Science Day are made by a committee of high school teachers with the cooperation of a representative from the science staff of the regional institution. Projects exhibited are expected to illustrate some phase of the following major fields of science: Botany, Chemistry, Geology, Physics, Zoology, Mathematics or applied subdivisions not readily limited to any one field, such as photography, conservation, agriculture, health, consumer science. The exhibits may be in the form of collections, experiments, apparatus or papers, although papers are not encouraged. All exhibits are intended to represent something the student has done in addition to class work. Each student entrant pays a fee of 50 cents. This fee together with the fact that he has presented an exhibit makes him a Junior Member of the Ohio Academy of Science. He has no voting privileges and can hold no office. Projects are judged by members of the science staff of the district institution working in pairs. Awards made are rated as satisfactory, good, excellent, superior. Certificates attesting the appropriate awards are given to exhibitors.

Winners of a superior award in the districts are entitled to enter their exhibits in a statewide Academy of Science Day held in connection with the annual meeting of the Ohio Academy of Science. Exhibitors at an Academy Science Day must belong to one of the four upper high school grades. At district exhibits pupils from the seventh and eighth grades may be admitted at the discretion of the district committee. There is no fee for entering the Academy exhibit. Exhibits are judged by teams made up of one University and one high school science instructor. Awards are the same as for the district, except that no grade of satisfactory is given. A certificate bearing the seal of the Ohio Academy of Science is given each exhibitor. In addition, scholarships are available in the state universities to outstanding exhibitors. In order to be eligible for a scholarship the student must have received a superior award in the state Science Day, must have satisfactorily passed a Science Achievement Test supervised by the Academy, and must have a B average in high school.

The judging of exhibits upon which awards are based involves a personal interview with the student as well as an inspection of his entry. The interview is directed toward discovering the student's understanding of his particular project, the field with which it is allied, as well as his interests and personality. Quality of the exhibit and an intelligent grasp of its significance weigh heavily in making a decision. Decisions of the judges in the form of certificates of award are announced at an Awards Meeting at which time the certificates are handed to the students. At the district meetings a representative of the district institution usually extends greetings and a member of the science staff speaks briefly on some scientific topic. At the Academy Meeting the president of the Academy or his representative extends the greetings of the Academy and speaks informally to the students and their instructors and friends.

Since accomplishment among high school students reflects the influence of their high school instructors, an attempt has been made to recognize the important role played by the high school teachers. Special recognition is each year given to one teacher from each district who has shown outstanding success in developing an interest in science among high school students. The award is a paid-up membership for one year in the American Association for the Advancement of Science

with a choice of either Science or Scientific Monthly. The selected teachers are invited to be guests of the Ohio Academy at its annual dinner. A letter, calling his attention to the fact that one of his teachers has been selected for special recognition by the Ohio Academy of Science, is sent to the teacher's superintendent and he is congratulated for having such a teacher on his staff.

The Junior Academy Council, which is the executive body for the Junior Academy activities, is composed of the chairman of the Science Education Section, its membership committeeman, a college instructor and a high school instructor from each district, the editor of the Newsletter, and the executive secretary of the Junior Academy. The district institution representative, the editor and the secretary serve for a number of years. High school district representatives serve one year, the Science Education Section representatives serve two years. The Council functions under the authority of the Ohio Academy. Within the limits of this authority it makes all regulations for the Junior Academy.

By way of stimulating interest and keeping various high school science teachers informed of activities, a Newsletter is issued four times a year and sent without charge to all high school science teachers. At least one issue per year is sent to superintendents and principals.

The reaction of both students and teachers to this Junior Academy plan has been most encouraging during the two years it has been in operation on a statewide basis. The first Academy Science Day was held in connection with the Denison University Meeting of the Academy in 1949. On that occasion 78 high school students entered exhibits, each of them having previously been awarded a superior rating in a district Science Day exhibit. The total number of entrants in the district exhibits held that year was about 600. The Science Day held in connection with the 1950 meeting of the Academy at Capital University had 130 entrants and the district Science Days of that year had a total entry list of 759. The quality of exhibits in both years was remarkably high. In the past two years district Science Days were held at the five state universities only, but this year Muskingum College will be added to the list.

In this connection it should be said that the state universities were selected as initial Science Day centers because they are so placed geographically as to lend themselves to a well balanced division of the state into districts. It was felt that if the Junior Academy took root at these centers, additional colleges or universities could be selected as growth occurred. Growth has occurred and it is for this reason that Muskingum College was asked to serve as an additional center. As rapidly as conditions make it necessary other institutions will be selected and it is hoped that those chosen will find it possible to serve.

An encouraging aspect of the Junior Academy plan is the generous support which each of the five state universities has given to the scholarship feature of the plan. Each university has set aside a certain number of tuition scholarships. The understanding between the universities and the Academy is that within the limits of the quota each university has set, each one will stand ready to give scholarships to those students who have been awarded a scholarship privilege by the Academy. This scholarship feature of the Junior Academy activities is one in which all of the colleges and universities of the state can immediately take part. The plan as just outlined is quite simple and the Junior Academy Council is anxious to have as many as possible of the colleges and universities join those now associated with the plan.

Just a word regarding finances. As mentioned before, each student who enters a district exhibit pays a fee of fifty cents. Part of this is retained for district expense and part is used for statewide expenses. The district institutions also contribute toward expenses incurred in the district. The Academy of Science appropriates funds to aid in defraying general expenses. The Newsletter is the largest item of general expense. Its printing is paid out of the Academy funds.

Mailing costs of the Newsletter have been assumed by the districts. The districts also defray the costs of their Science Days. Included is a complimentary luncheon for teachers and a variety of incidental expenses. The general fund for the state, in addition to paying for the Newsletter, covers the cost of printing certificates of award, providing ribbons and seals used on the certificates, as well as various other incidental expenses connected with the state as a whole. The general fund also pays the membership fees in the American Association for the select group of teachers and their Academy dinner charges.

Finally a word of deep appreciation is due the officials of the respective institutions which serve as district centers for the generous manner in which they have supported the Junior Academy both by helping to defray local expenses and by showing a real personal interest in the undertaking. A similar word of great appreciation is, of course, due the officials and the Council of the Ohio Academy of Science for their whole hearted interest in the Junior Academy, an interest expressed both by generous financial support and by personal efforts.


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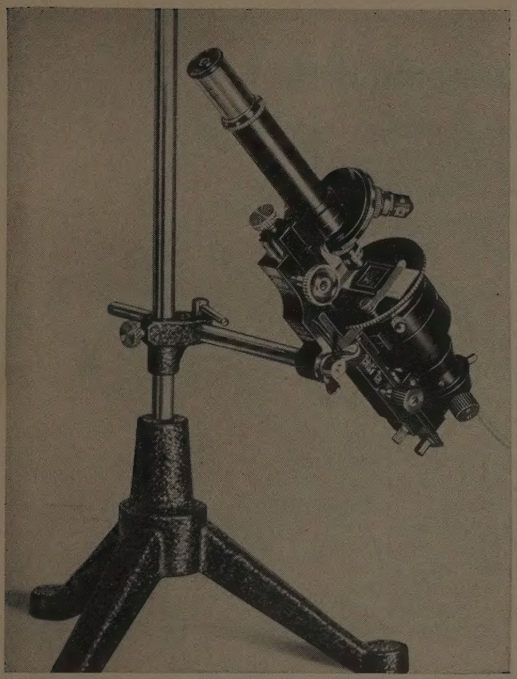

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